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ABSTRACT

Progress made on the development of a plan for evaluating the cost performance and educational benefits of the TICCIT and PLATO projects is summarized in this annual report. The basic focus of the first section of the report, Cost Analysis, is to provide answers to the fundamental question of how much these two CAI methods cost compared with some measure of non-CAI "baseline" educational costs. The second section, Educational Analysis, describes the baseline educational analysis that will be implemented during 1972-73. Attention is given to achievement and attitude measurement, the experimental design, and plans for data collection. In the third section, Technical Analysis, the progress of the two systems to-date is summarized, as based on site visits to both the University of Illinois and MITRE, in relation to system development, decisions that will be important in the determination of the nature of the final system, and the adequacy of the method for collecting system performance data. An extensive bibliography, with brief annotations, lists recent writings related to the subject of computer-based education in general and those technically related to the research, development, and evaluation concerns of the project. The two appendices to the report are: A. Survey of Instructor Activities and Attitudes, and B. Attitudes toward Reading Questionnaires--Grade 2 and Grades 4 and 6. (For related documents, see TM 002 297, 298, and 386.) (DB)

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PR-72-19

Evaluation of the PLATO and TICCIT Computer-Based Instructional Systems--A Preliminary Plan

Ernest J. Anastasio

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ANNUAL REPORT

Contract No. NSF-C731

July 31, 1972

EDUCATIONAL TESTING SERVICE
PRINCETON, NEW JERSEY

ED 072070

ANNUAL REPORT

An Evaluation Of The Demonstrations Being Conducted By The University Of Illinois And The MITRE Corporation Of Their Respective Computer Assisted Instructional Systems

Submitted By:

Ernest J. Anastasio
Educational Testing Service
Princeton, New Jersey

Under Contract No. NSF C-731

to

THE OFFICE OF COMPUTING ACTIVITIES
THE NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C.

July 31, 1972

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TABLE OF CONTENTS

	Page
Introduction	1
Cost Analysis	4
Overview of Cost Structure	5
Cost Categories - CAI Projects	7
MITRE Project	7
Illinois Project	12
Cost Categories - Community Colleges	16
Educational Analysis	19
Achievement Tests	19
Attitudes and Activities	22
Experimental Design and Data Collection Plans	26
References	34
Technical Analysis	36
The TICCIT System	36
The PLATO System	37
Data Collection	37
Bibliography	39
Appendices	51

A. Survey of Instructor Activities and Attitudes
B. Attitudes Toward Reading Questionnaires
   a. Grade 2
   b. Grades 4 and 6

ANNUAL REPORT

Period: 7 February, 1972 to 31 July, 1972

The following report is submitted in partial response to Contract NSF C-731. The major objective of the report is to summarize progress on the development of a plan for evaluating the cost performance and educational benefits of the TICCIT and PLATO projects.

Detailed plans for the baseline cost and educational data collections are presented as well as our current thoughts on the design of the technical evaluation. In addition, we provide an annotated bibliography of recent publications relating to the use of computers in the instructional process.

We are satisfied that progress in the implementation of PLATO and TICCIT has been reasonable, with the exception of the course development area. Some delays have been encountered in the development of the delivery systems; however, for the most part, these delays have led to more carefully defined plans for the two systems and to greater promise of a useful demonstration.

Course Development

Perhaps the most uncertain and potentially disturbing aspect of the development of both the MITRE and the University of Illinois projects has to do with the authoring process. No matter how well designed and reliable the hardware, or how flexible and powerful the supporting software, the educational progress of students using each system will be limited by the nature of the curricular materials presented to them. In quite opposite ways, both projects run the distinct risk of underestimating what is required to produce an effective curriculum. MITRE's approach to curriculum design could easily err in the direction of excessive and premature systematization of materials lacking in adequate realization of the potentialities of the medium for delivery. Illinois, on the other hand, could easily err in the direction of excessive reliance upon highly inspired adjunctive exercises demonstrating the great versatility and creative potential of the medium but inadequately supported by comprehensive, systematic coverage of curricular objectives. In our view, these risks are very real and must be recognized and dealt with if the delivery systems are to be given a fair trial and evaluation.

To emphasize this point by analogy, suppose that the Air Force had under development a radically new design of fighter bombers and was preparing to test their effectiveness under combat conditions. We would expect them to insist upon experienced pilots and highly trained flight crews. And we would not regard it as a fair test of the new aircraft if the crews were selected on the basis of interest, ground artillery experience, knowledge of the combat terrain, or any other tangential criterion. Analogies are sometimes misleading, and we do not wish to push this one too far. The counterpart of an experienced flight crew, thoroughly skilled for coping with both a new craft and with combat conditions, would be extremely hard to find or assemble in the field of CAI. MITRE and Illinois are both to be commended for the ingenuity and perseverance with which they have faced the task of authoring for new media and for specific curricular problem areas, but the fact remains that both may have discounted too much the skill, training, and experience needed for effective authoring.

Illinois seems to have been carried away by their own enthusiasm for the power of the new medium, and to have given insufficient attention to the detailed work of defining educational objectives and implementing scripts. The possibility that the content of a PLATO program could be based on an inadequate educational strategy has not been faced. MITRE, on the other hand, has placed inordinate faith in educational objectives and adopted an assembly-line authoring process before even a small-scale prototype of a functioning program could be demonstrated or revised. Contrary to the experience of others, they are attempting the basic authoring input into the assembly line without the benefit of early direct contact with an operating system. A very difficult task is left to the instructional designer to take the bits and pieces and assemble them into an imaginative, challenging lesson.

Some risks are inevitable for any large, ground-breaking innovation, and both the MITRE and University of Illinois projects would be impossible without accepting risks. It is, nevertheless, important to reduce the sources of risk in every reasonable way. One can perhaps justify MITRE's insistence upon assembly-like authoring techniques as essential to the eventual economic viability of their overall system, or Illinois' confidence in inexperienced authors as part of a grand conception of how an essentially new medium must develop its own freedom and style independent of the conventions and discipline of textbook authoring. But it should then be recognized that any evaluation of these systems and of students' educational progress will be to some degree jeopardized. In any case,

unnecessary aspects of the compounded risk should be eliminated -- MITRE by exposing authors to the medium and its possibilities as soon as possible, and Illinois by taking steps to assure that basic educational objectives are adequately covered.

COST ANALYSIS

This section describes the structure of a cost-collection system that has been designed to provide much of the basic data to be used by the cost-analysis team for its financial analyses. Also included is a brief review of the cost team's activity through June 30, 1972, as well as a calendar of plans and objectives for implementing and reviewing the proposed cost-collection program for fiscal 1972-1973.

The principal purpose of capturing both direct and indirect costs over time is to explain from a financial standpoint the development, implementation, and operation of each system and the system's relationship to the educational process. The basic focus of the cost analyses is to provide, as reliably and objectively as possible, answers to the fundamental but difficult question of how much these two CAI methods cost compared to some measure of non-CAI "baseline" educational costs. Since both of the CAI systems are experimental, we feel it imperative to extrapolate trends from the collected cost components in order to make reasonable estimates of future costs of these or similar CAI systems. It is our conclusion that the complex financial questions that are bound to arise, and the natural interest in comparing alternative hardware and software modules within each system itself, necessitate a comprehensive cost structure. To compute over-all average costs, while a simple and certainly a useful procedure, would result in too gross an aggregation for our purposes.

Thus the structure outlined in this section reduces the two systems to the "component" level, for hardware, software, and courseware. We also single out administrative and out-of-pocket costs. This analysis is particularly important since changing to perhaps similar but alternative approaches to various components will possibly occur in the current system implementations and will very probably occur in follow-on systems. A further concurrent distinction is provided to separate developmental, capital, and operating costs. These differentiations are essential for predictive purposes.

The cost-collection systems outlined for TICCIT and PLATO have been made as broadly compatible as possible. Each CAI system, however, has a unique approach and special circumstances that must be accounted for. For example, the Illinois project has been in operation for a much longer time than the MITRE system, but it would scarcely be beneficial to attempt an historical account now of detailed developmental costs for the Illinois effort. As a consequence, the newer MITRE system is likely to appear comparatively heavy on development costs. To give a fair picture of the economic effects and potential

of each of the two CAI systems, developmental costs will be systematically separated from operating costs. It should be clear that a gross average of total cost divided by some unit of usage would give, in this case, an unrepresentative view of the true situation.

The cost-analysis team must provide accounting mechanisms that operate so smoothly as to minimize the possibility of disturbing the participants. Fortunately, the MITRE, Brigham Young, and Illinois projects have administrative personnel who are very capable in financial and accounting matters. Although the cost classifications presented here have not yet been formally reviewed by these administrators, our review of the existing accounting mechanisms indicates that implementing our plan can be accomplished with the requisite smoothness. The areas where precise data may be lacking are indicated in the description of the cost structure, and methods of estimation are noted. In most cases, however, cost data by the categories described are already being collected by the participants, on their own initiative, or we have discussed them with the participants and reached the understanding that they can be collected.

Overview of Cost Structure

During the next year the cost-analysis team will assist Illinois and MITRE in accumulating development costs within four major categories: hardware, software, courseware, and administration. The team is well aware of the many differences between the projects, not only in systems concepts but in implementation methods, length of project life, organizational structure, and the like. Despite these differences, however, it is felt that common categories can be worked out that will be consistent and comparable.

A. Hardware

Both projects rely upon purchased off-the-shelf components for the significant part of their system. These components are either used as is, or are modified by project personnel for special use. Both projects should, therefore, be able to accumulate the purchase or lease costs of equipment, and accrue the costs of modification through the personnel accounting system. For uniquely developed components, a unit cost will have to be established.

B. Software

Both projects are investing heavily in special communications software, the handling of terminal interactions being one of the major tasks of the communications processors. These

developments are being conducted by the project teams and can be captured as part of the data collection requirement. In other instances there is modification of vendor-supplied software which is subject to the same consideration.

C. Courseware

The development of course materials is, in a sense, being subcontracted by both projects. The MITRE project has centralized its courseware effort at Brigham Young University. The project costs can be closely monitored with little difficulty. The Illinois project's courseware effort is decentralized, involving teachers and other staff of the several schools and colleges where the PLATO system is to be used. Gathering these costs will require the special attention and cooperation of all persons and schools involved, if we are to get a comprehensive picture. A subsequent section of this report details how data are to be collected for the courseware.

D. Administration

Both projects are subentities of larger organizations, i.e. the MITRE Corporation and the University of Illinois. Although the two institutions operate for different purposes and with different types of bookkeeping, the administrative structure of the projects includes all of the normal personnel and overhead costs that one would expect to find in that context. We are confident that the individuals who carry the administrative burden of the projects can meet our requests for comparable administrative cost data.

The principal contacts for gathering cost information are:

TICCIT Project

MITRE	Ned Burr
Brigham Young	Stuart Low
Northern Virginia Community College	To be determined
Phoenix	Marvin Lassila (Maricopa County Community College District, Comptroller)

PLATO Project

CERL/Illinois	Frank Propst
Chicago Community College System	Donald Hill (Vice-Chancellor, Fiscal Affairs)
Parkland Community College	David Johnson (Director, Learning Resource Center)
Urbana School District	To be determined

E. Site Development

Each project will have to modify the school site to accommodate the terminals and communication equipment. These are one-time costs and will be obtained as they occur.

Cost Categories - CAI Projects

The cost categories described below have been established for data collection at MITRE, Brigham Young, and Illinois. None of the categories is described exhaustively, and it is possible that some of the particular pieces of hardware or software have been superseded since our most recent visits. Our purpose at present is to explain the structure of the cost-collection system rather than each specific detail, but we have tried to provide enough representative detail to clarify intent.

Each of the projects will have costs collected into the five general categories of hardware, software, courseware, administration, and incremental site (out-of-pocket) costs. These five categories appear to be natural choices. They form a comfortable way of conceptualizing the projects, being easily understood by CAI experts as well as those less knowledgeable; they provide the cost-analysis team with the type of data sought; and they are already being used to some extent to organize efforts and personnel, thus simplifying our cost collection.

In each of these five categories and in the respective subcategories, we plan to distinguish among development (one-time) costs, implementation costs (one time for each site), and operating costs (recurring). As our experience with the project grows, it should become progressively easier to determine where costs fall in this three-part classification scheme.

It is evident also that the question of allocation of fixed-capital outlays will not be simple to resolve. In this discussion of structure we make no attempt to note either which costs are of this type or which way to allocate them, but simply record our need to contend with the question.

A. MITRE Project

1. Hardware

Hardware development costs have been divided into five subcategories. We shall accumulate information on dollars expended, using purchase costs for off-the-shelf items

and development costs for MITRE-produced items. The MITRE-produced components will be difficult to cost evaluate for two reasons. First, the present level of detail may not be sufficient to permit our getting exact figures, and second, the quantity produced may be so small as to reflect an abnormally high cost. We hope that discussion with involved personnel can help enough to prevent this potential problem. We are also aware, however, that most of the MITRE equipment is composed of off-the-shelf items with specific purchase prices; thus, the cost problem of in-house production will not be great.

Hardware has been separated into four parts according to the function of specific pieces of equipment; a fifth category covers hardware-related personnel costs.

a. Processor Facility

In this subcategory are included all the equipment normally associated with the operation of a primary central processing unit in a computing center -- the main processor (a Data General NOVA 800) in this case, plus any directly associated peripheral equipment such as card reader, printer, magnetic tapes and drives, courseware and data disks, and swapping disks or drums. It is our current understanding that all of these items are to be purchased as standard equipment from manufacturers, and that each community college will require a full complement of this equipment.

b. Communications System

Under this subcategory is grouped the associated hardware required to transmit messages from the central site to the student terminal. Some items such as the communications processor (also a NOVA 800) and the linking disk are readily available, with manufacturer's prices. Other items such as the character generator, video refresher, color encoder and switches, and audio switch are also included under communications. They are all MITRE-designed and, except for the video refresher, will probably all be MITRE-produced. The fact that all fall under the same subcategory somewhat simplifies the cost-collection task.

The items included under communications could conceivably fall into other subcategories (linking disk as part of the processor facility, color encoder as part of the terminal), but we felt that they were all performing the distinctly identifiable function of communications that should be separated from the central facility and the terminal itself.

c. Terminal

This subcategory represents the part the student sees directly -- the TV set and keyboard. An illustrative cost problem that arises in this connection is that selected parts and capabilities of the standard TV set may not be necessary for CAI and may have to be removed, thereby lowering the thecretical but not currently actual cost of the terminal.

d. Audio/Video and Other

The audio playback units and the video playback units will be costed separately, since it seems conceivable that a "stripped-down" system could function with a subset of courseware modules without these devices.

e. Personnel Costs

Personnel costs consist of the professional engineering staff and their supporting clerical assistance, classified by MITRE to be working on TICCIT system.

We expect the normal activities of modifications and repairs to fall into this category. Note that the personnel cost of MITRE-produced hardware components is included in other (notably communications) subcategories. It is our conjecture that a substantial personnel effort may be expected to assemble, integrate, and test all of the various hardware components to make them work as a unit, since many were produced for non-CAI purposes. Such costs will be included here, if they do occur.

2. Software

Software development and maintenance costs will consist primarily of personnel costs, unless additional computer time has to be purchased from an outside time-sharing vendor. Costs will include, but not necessarily be broken out by, design, coding, implementation, debugging, and testing of all the many necessary programs. Following the natural organization of MITRE, we divide the software costs into three subcategories:

a. Application Software

This subcategory includes graphics routines, response-parsing routines, programs to track performance, learner- and advisory-control programs and the data formats on which they may operate. These programs in a more

conventional system might be thought of as the "language" that would provide the necessary facilities and functions to a programmer/author. However, MITRE's approach is unique, and we feel it necessary to move the basic application functions into this subcategory, but to consider the "authoring" software separately.

b. Authoring Software

This subcategory consists of the development of programs to "pre-process" course material from some prespecified format to an ALGOL computer program. Thus we need costs for any ALGOL compiler modifications, but more importantly for the development of an on-line source data entry system. The uniqueness and promise of MITRE's attempt to free authors from computer programming warrant monitoring that development separately.

c. Delivery Software

Despite the fact that Data General supplies a standard operating system (RTOS), it probably will have to be modified, to cut out some of its general, unneeded functions, and to add others peculiar to this CAI project. We would also include here any programs or subprograms necessary to process student records and to operate the terminal processor.

3. Courseware

Courseware costs are being accumulated at Brigham Young University according to a format worked out by the cost-analysis team and members of the project staff. The following table lists the various courseware development specialists. Costs would be accumulated in dollars-per-hour according to the time spent by each of these specialists to prepare a base frame of instructional materials per course during: 1) the initial stages of the project, 2) the transient stage of the project, and 3) the final, or steady-state of the project. The purpose of this type of analysis is to display the "learning curve" aspect of courseware production that is characteristic to the activity. The information would be among the most pertinent for future users of this type of authoring system. It is anticipated that time and costs will be gathered monthly on a course-by-course basis.

TABLE I

Differential Hour Accumulation Table
BYU Coursware Project

Mathematics I	$/hr	Initial Hours-Frame	Transients	Steady-State
Instructional Psychologist				
Instructional Design Technician				
Empirical Design Technician				
Packaging Specialist				
Author				
Program Implementation				

With the exception of Program Implementation, all course development costs will be collected at Brigham Young University. Program Implementation costs will be gathered at MITRE.

4. Administration

The costs related to resources and to individuals concerned with the administration of the courseware development at BYU will be accumulated as a separate category. These costs will then be allocated to each course monthly on the basis of the ratio of each course-development cost of the total developmental costs for the month, e.g.:

$$A_i = \frac{CH_i}{\sum_{i}^{m} CH_i} A^*$$

A_i = Individual Administration Course Costs

CH_i = Developmental Hour Costs in Table I

Σ = the sum of all Developmental Hour Costs

A^* = the monthly total of Administration Costs

It is assumed these costs will primarily include Mr. Low's salary, secretarial costs, and those of occasional administrative assistance support. Working with Mr. Low, we intend to isolate requisite clerical costs for the operation of each course.

5. Incremental Site (Out-of-Pocket) Costs

These costs include expenditures which must be made to adapt a site to the technical requirements of a TICCIT system. They would include such facilities preparation as air conditioning, electrical wiring and fixtures, and facility modification. Other operating costs likely to occur are telephone-line installation and rental. Any other significant costs that can be isolated will also be included, possibly such as space cost.

B. Illinois Project

1. Hardware

Hardware costs for the PLATO project have been divided into the same five subcategories as for MITRE. We shall accumulate dollars expended, using purchase or lease costs for off-the-shelf items and development costs for items produced at the University of Illinois. The specific items under each heading, however, could not be more different for TICCIT and PLATO, reflecting as they do the very different approaches of the two CAI projects. Such differences will thus make direct comparisons of subcategories misleading and, by and large, inappropriate.

a. Processor Facility

This subcategory is primarily the rental of a standard CDC 6400 with its large extended core storage. All disk units are included under this heading. We are not aware of any peripherals, such as card reader or magnetic-tape drives on the PLATO system. We have also put the peripheral processor units in this subcategory since they are an integral part of the CDC 6400 (even though one could view their function as communication).

b. Communications System

In this subcategory we have the main network interface unit, and site controllers. This latter equipment is produced and maintained in-house. There is likely to be included here a relatively large telephone-line (coaxial cable) charge since the terminals will be

driven from a single central site at the University of Illinois rather than from a local processor.

c. Terminal

The plasma display terminal used by PLATO was invented and developed at the University of Illinois and is now being produced commercially. It entailed a substantial developmental expense over many years; we shall not collect these costs.

The terminal also comprises a keyboard, a touch panel, and a microfiche slide projector that operates under computer control.

d. Audio and Other

The random-access computer-controlled audio unit is in this subcategory. At this time it is the only separable unit, and the system can be operated without it.

e. Personnel Costs

These costs will primarily be those associated with installation and maintenance related to hardware -- particularly for the main computer, communications, and the plasma terminal. Since PLATO has been in existence for several years much of the integration work has already been done, but the process of developing maintenance routines and documentation will incur some personnel expenses.

2. Software

Following CERL's natural organization, software is divided into three subcategories; these are quite different from MITRE's, owing to the nature of the approach. The software cost is primarily personnel costs of design, coding, implementation, debugging, and testing. Since a large number of programs are already written, a large segment of the costs collected will be for additions and improvements, or conversion from PLATO III to PLATO IV.

a. Authoring Software (TUTOR Language)

Development and modification of the main authoring language now widely used on PLATO are under this heading. The editing routines would also be included here, as well as the proctoring program, since these serve an authoring function as opposed to a systems function.

b. System Software (Operating System and Monitor)

This subcategory includes any modifications necessary to the standard operating system for the CDC 6400, such as stripping away the unneeded magnetic tape functions. It may be that further changes will be required as large numbers of new terminals are added to the system.

c. Courseware Support

Under this subcategory we have included any routines such as the master program that manage the lesson material and keep track of student records and the like.

3. Courseware

Courseware is to be developed with Illinois staff assistance in the Chicago Community College System and at Parkland Community College. Specific faculty members will be given released time for one year or longer on a half- or full-time basis to develop course materials in TUTOR on the PLATO system. This method contrasts markedly with the TICCIT effort centralized under Professor Bunderson at Brigham Young University. The lack of centralized effort may make course costs somewhat more difficult to follow, but there are PLATO personnel assigned to coordinate this effort who can assist with the accumulation of costs on a course-by-course basis.

Courseware costs will be collected in the following two subcategories:

a. Direct Faculty Costs

We intend to divide the process of course development into four distinct stages:

1) Time to learn TUTOR

2) Time to develop a module, including planning time and time on the PLATO terminal

3) Time to test a course module

4) Time to document a course

While such analytic data may not be readily available, we find the effort to produce the data essential. Previous CAI systems have come under criticism for not being oriented to faculty, and it seems that the PLATO system has the potential for avoiding such problems. This fact needs to be cost documented.

We expect to develop time-recording procedures for the individual instructors in the community colleges. In addition, we have established that it is feasible to track faculty use of the system with "PROCTOR." At present we hope to accumulate automatically all console time on a course, and, using the time records, to key it to off-system effort.

b. Author-Support Costs

We group into this subcategory all non-personnel costs associated with writing a course -- such as photographic, recording, drafting, art work, publications, and library-support costs. These costs will be recorded at the CERL as a separate charge to each course.

4. Administration

We intend to follow the same approach used with the MITRE system. Administrative costs will be more diffuse; the community colleges as well as Illinois are expending administrative effort. The development of an adequate, comprehensive system for administration will be on a trial-and-error course in the coming months, but the costs to expect seem obvious. Initial general categories are faculty administration, student administration, and clerical.

5. Incremental Site (Out-of-Pocket) Costs

These costs include expenditures that must be made to adapt a site to the technical requirements of the PLATO system. Since the central processor is to remain at CERL, extensive site preparations will be avoided. Installation of the site controllers will be included here, as well as installation of terminals. Other operating costs likely to occur are local telephone-line installation and rental. Any other costs that can be isolated will also be included, such as possible space costs.

Cost Categories - Baseline Course Costs for Community Colleges

The baseline costs of education in a community college environment, as they are perceived by current financial data systems used in most schools, consist of faculty compensation, space, departmental costs, student expenses, and auxiliary costs. For some courses, such as math, these auxiliary costs may not be important, but for English and the science courses they are supportive resources which must be evaluated economically with and without the CAI investment. A second important consideration is how the teacher spends time with and without CAI. We intend, in 1972-73, to gather data which indicate on a percentage basis how an instructor spends time in the schools selected as prototypes for the CAI project. This is a delicate process, as we need the instructor's cooperation for all manner of data collection. Our intent is to develop anonymous measures of several individuals, within the project and without. Compensation may be provided to instructors for their assistance in filling out time-analysis forms. The initial forms will be simple, developed with the teachers in order that they understand our objectvies. The base costs for the community college instructor activity probably have some situation-specific elements, but they also include general factors of teacher behavior that can be verified at other institutions. The plan is to develop the community college base costs in the PLATO project and if necessary refine them in the MITRE demonstration sites.

In all of the following cost areas, the basic item of information sought is the cost of teaching the individual student under present methods in a given course.

A. Direct Faculty Costs

In every educational situation today, faculty salaries are by far the largest item of expense. In most instances faculty members are paid either on an annual (school year) basis with a minimum teaching load being described, or on a semester course basis, in the case of part-time teachers. In each instance, the instructor's efforts are described in terms of the amount of time he spends in class. In some cases faculty are paid additional amounts for course preparation or for attendance at workshops and conferences that relate directly to the courses being taught. The direct faculty costs that will be gathered for baseline analysis will be:

1) Teaching hours -- the average and total hourly cost of teaching the courses being prepared for CAI. A taxonomy, that sorts time into classroom, counseling, and grading, will be the starting base. It is assumed that experience with the teachers will allow us to refine this taxonomy.

2) Hours of preparation

3) Total hourly cost of out-of-class paid time for courses being prepared for CAI as noted under Courseware Development for normal class preparation, including library work, correspondence, and graphic or hand-out preparation.

B. Allocated Space Costs

The space costs of education in the community college will be collected, to include:

1) Average classroom costs for courses being prepared for CAI.

2) Average cost of any other special study space used for these courses.

C. Direct Departmental Costs

The overhead costs of running community college departments will be added on a per-course basis. The auxiliary library and laboratory costs will be included in this category. Primarily the cost will be administrative time to plan and implement the coordination of students to facilities, in order to provide a course of instruction. In addition, registration and record-keeping costs will be accumulated.

D. Student Costs

Although rarely shown as a cost to the community college, there are costs to the student under the present method of teaching that could be directly affected by the use of CAI. An aspect of this category is the informal activities of the student in campus unions or off campus. We intend to work with the school administration and a committee of students to develop methods of accumulating data on these activites. Because we have not yet had an opportunity to discuss our needs with individuals at the demonstration sites, we are unable to be very specific about the form in which these data will be recorded. Thus at this time we propose only to collect two items of student costs as part of the baseline cost study, although we assume the cost system will be modified with experience:

1) Textbooks and standard fees (if any). Most courses require the student to pay for materials that are to be retained, and occasionally for the use of special equipment or services (such as computer time) in the school.

2) Class time (or time to complete a course). Many students in community colleges are working at the same time, or are in school only until they can complete a particular program so that they can enter a profession or trade. For that reason, there is an opportunity cost to the student if the course of study takes twice as long by one method than by another.

The cost-analysis team anticipates that these cost categories will be refined and expanded, as necessary, when closer contacts have been made with all of the community colleges participating in the CAI project. Our feeling at present is that baseline cost data of an uncomplicated sort should be the goal. Most educators who are considering the CAI method of teaching either as an addition to their current program or as a replacement for classroom teaching are concerned about the comparison of one method with the other on a cost-per-student-hour basis, and that is what the cost analysis is designed to provide.

EDUCATIONAL ANALYSIS

This section describes the baseline educational analysis that will be implemented during 1972-73. Attention is given to achievement and attitude measurement, the experimental design, and plans for data collection.

The discussion of achievement measurement includes a rationale for using standardized tests as a basis for comparison and for using item-sampling and multiple-matrix sampling techniques to obtain group measures. A discussion follows of the techniques for attitude measurement, with brief descriptions of survey and interview procedures projected for the coming year. A final section details the experimental design and our plans for baseline data collection. It also summarizes several important questions that must be considered before we can estimate the effectiveness of computer-based education.

Achievement Tests

Standardized achievement tests offer a number of potential advantages for the evaluation of instructional programs. Shoemaker (1972) lists four advantages: no developmental costs, relatively low cost, development by professionals, and availability of validity data. Broadly interpreted, the last of these advantages is of particular importance to an evaluation. Prior information about the psychometric properties of the instrument can insure that the measure has sufficient reliability for the intended use, that it is appropriate in terms of difficulty level for the group in question, and that it has validity for the intended purpose.

Normative data available for standardized tests provide an additional basis of comparison for new programs. Although such comparisons are subject to many pitfalls, they do help in the communication to a wide audience. Performing very well on a well known standardized test provides additional credibility to claims of program success -- more than can be achieved by comparisons within the evaluation study, using unknown instruments.

The normative comparison value of standardized tests will be particularly important in the evaluation of the elementary school component of the Illinois demonstration. Whatever additional values a program may have, there is a need to provide public assurance that elementary school students are achieving adequately in the areas of reading and arithmetic as reflected by scores on the standardized achievement tests.

Although standardized tests will play an important role in the evaluation of the MITRE and Illinois demonstrations, it would be unwise to depend only on them. There are disadvantages as well as advantages to using standardized tests; thus we plan to complement the standardized tests with other testing procedures that are not subject to the same disadvantages. In particular we shall attempt to use other testing procedures to overcome two important limitations of sole dependence on standardized tests. These limitations are related to test length and to content coverage.

Since most standardized tests are designed for individual assessment they are longer than they need to be for purposes of group comparison. The basic concern of program evaluation, however, is with group comparison rather than individual assessment. The unnecessary test length results either in an unduly heavy burden on students and teachers in terms of testing time or it limits the evaluation to a narrow domain of test content. The former alternative can result in resistance from students and teachers, and the latter can result in a failure to detect important program strengths or weaknesses in areas not measured. For a given amount of testing time there is a trade-off between fidelity (i.e., the accuracy of measurement of a given dimension) and bandwidth (i.e., the number of different dimensions or component skills that are assessed) (Cronbach & Gleser, 1965). Since less fidelity is needed for group comparisons than for individual measurement we plan to supplement the core standardized tests with short tests using the item-sampling techniques discussed later in this section.

As noted, a major disadvantage of standardized tests is related to their content coverage. In order to be widely applicable, standardized tests must be fairly general in nature to insure their appropriateness to many different types of instructional programs. Yet as Hartnett (1971) has noted, making a standardized test broadly applicable may also make it insensitive to important program differences in more specific outcomes. According to Shoemaker "the primary limitation [of a standardized test] is that such a test is not likely to contain both the breadth and depth of content coverage necessary to make a detailed assessment of any instructional program. This insensitivity of the test is likely to lead to the conclusion of 'no difference' among programs having distinctly different characteristics" (Shoemaker, 1972, p5).

As we have indicated, we plan to complement the standardized tests by item sampling and possibly multiple-matrix sampling techniques in obtaining group measures. In item sampling a short test that is n items in length is constructed by random or stratified random sampling from a pool of $\bar{n}$ items where $\bar{n}$ is greater than n. The short n-item test can then be used to obtain estimates of mean performance for the pool of $\bar{n}$ items (see Lord & Novick, 1968 pp 253-254). For purposes of evaluation, however, the estimate of the mean on the $\bar{n}$ pool is less important than the simple comparison between the means of the demonstration and comparison groups on the n-item test.

An alternative to having each student take several short tests would be to have samples of students respond to different longer tests. For example, if tests in five areas were needed, each consisting of 100 items, a choice might be made between giving a sample of 20 items from each test to all examinees or giving one of the 100-item tests to non-overlapping samples of the students. The relative strengths of these two approaches may be contrasted by considering the sampling variance of mean proportion of items answered correctly, $\bar{z}$, which can be written

$$\bar{z} = \frac{1}{nN} \sum_{g=1}^{n} \sum_{a=1}^{N} y_{ga}$$

where y_{ga} is the score for examinee a on item g ($y_{ga} = 1$ if correct, and 0 if wrong), n is the number of items and N is the number of examinees. If the n items are a sample from a larger pool of $\bar{n}$ items and the N examinees are a sample from a population of $\bar{N}$ examinees, then the variance of $\bar{z}$ given in Lord & Novick (1968, equation 11.11.6) is a function of n, $\bar{n}$, N, $\bar{N}$, σ_p^2, σ_Z^2, and Z. The capital Z is used to refer to scores of all $\bar{n}$ items in the pool. Thus $\bar{Z}$ is the mean proportion right for the $\bar{N}$ examinees on the $\bar{n}$ item pool and σ_Z^2 is the variance of the $\bar{n}$ item test. The term σ_p^2 is the variance of the difficulties of the $\bar{n}$ items. Formulas for estimating these terms may be found in Lord & Novick (1968).

The critical point for purposes of the present discussion is not the actual formulas but the implications of manipulating n and N on the size of the sampling variance of the estimate, $\bar{z}$. If σ_Z^2 is large relative to σ_p^2, as will generally be the case, the variance of $\bar{z}$ will be decreased if n is reduced and N increased, holding nN constant. Thus, for a constant nN, a better estimate of the group mean performance would be obtained by sampling items than by sampling examinees.

A more complicated but also a more powerful approach is that of multiple-matrix sampling. In multiple-matrix sampling, different samples of items from a common item pool are administered to different samples of examinees. An efficient multiple-matrix sampling procedure would be to divide the item pool of $\bar{n}$ items into M non-overlapping random samples of n to be administered to M non-overlapping random samples of $N = \bar{N}/M$ examinees. This approach can be shown to be superior to either item or examinee sampling. (see Lord and Novick, 1968, pp 255-258).

The use of multiple-matrix sampling for the evaluation of instructional programs has been strongly advocated by Shoemaker (1972). As

Shoemaker acknowledges, however, the multiple matrix approach can present serious problems of logistics since the different administrations of different subtests to different sub-groups will frequently require different oral instructions thus requiring greater disruption of normal classroom instruction. This difficulty has led us to elect a strategy of using standardized tests and simple item sampling for most of the testing that would be common to the comparison groups (baseline year and control groups during demonstration) and the demonstration groups.

The multiple matrix sampling approach can be used very readily with the CAI students. Therefore, we plan to make use of this approach in some of the on-line testing that will be accomplished during the evaluation.

Attitudes and Activities

Not only will these demonstrations produce changes in student achievement and cognitive skills, they will also quite likely affect the attitudes and activities of students and teachers. Indeed, the principal contractors have argued that attitudinal changes may constitute the most important effects of computer-based education. Attitudinal changes will, of course, be indirectly reflected in student achievement; we intend, however, to gather direct information to help us assess the influence of this mode of instruction.

It is important in projects as large and complex as these to determine how students react to the several components of their experiences. We should therefore measure not only attitudes toward specific courses, their subject matter, methods in which they are presented, grading systems, and appropriateness of initial placement of the student, but also alterations in faculty-student and student-student relationships, and attitudes toward studying and toward computers and computer-assisted instruction. A course that achieves its educational objectives but leaves the student feeling more than ever depersonalized or desirous of leaving school has gravely failed in its purpose. On the other hand, we may find a student's general attitude toward computers or studying significantly improved even though he has found the course material inappropriate. Such outcomes will require the most careful analysis.

Student activities will also yield information about potentially important educational effects of CAI. The number of times the student chooses to sign on to the system (this being related to his class attendance), the number of extra options he attempts, and the latency of his responses are relevant computer-related activities. We shall want to know how much time the student spends in study outside the classroom, how often he uses the library and other sources of supplemental information, and how frequently he has voluntarily contacted

faculty members or other models for stimulation and assistance. Similarly, we shall wish to assess the student's general educational progress seeking information on whether he drops the course or persists in it, and whether he does or does not take follow-on courses. Such data must be considered as noteworthy behavioral effects of this mode of instruction.

During the baseline year, the primary method we shall use for gathering data on student attitudes and activities will be to administer, to samples of students at the end of each term, parts of the following standardized attitude surveys:

1. Student Instructional Report (SIR).

This survey was developed to give faculty members an opportunity to have their students describe and assess their courses and instruction systematically and to give students a chance to express their views of the course and the way it was taught. SIR will, of course, furnish the same information for the evaluation team. Since 1971-72 was the first operational year for this instrument, comparative data are not yet completely available, but they will be ready when needed. There are 39 items dealing with subject matter, teaching methods, materials, and student-faculty relationships; there is also provision for ten additional items dealing with issues specific to this project.

2. Comparative Guidance and Placement Program (CGP) Student Questionnaire.

This survey asks students about their satisfaction with their courses, their major fields of study, and faculty-student relations. It is particularly appropriate for the MITRE project since it asks specifically about placement in English and Math courses. Comparative data on 6210 students from 26 junior colleges are now available, and more data will be collected each year. There are 47 items and provision for six additional, specially designed items.

3. College Student Questionnaire - Part 2 (CSQ-2).

Since the instrument was designed for use at four-year colleges, many items are inappropriate for this project. However, items with bearing on student attitudes toward faculty and student-faculty relationships, attitudes toward the administration and other students, sources of satisfaction and problems, study techniques and attitudes, leisure-time activities, and instructional preferences will be combined with items from the following three sources to provide an instrument appropriate for this project and yet drawing upon previous work in this field. Comparative CSQ data are available for 1500 students at 37 four-year colleges and will be updated within a few months, but these data will admittedly be of limited use since they come from four-year institutions.

4. College and University Environment Scales (CUES).

Several of the scales in this instrument (practicality, community, awareness, scholarship, campus morale, quality of teaching and faculty-student relationships) measure important potential side effects of CAI. Many items will be inappropriate since this instrument, too, was designed for the four-year colleges. Nevertheless, a recent study using CUES has gathered some comparative data from junior college students and found that some of the items worked very well in this context. These will be considered for use in our study.

5. Student Reactions to College (SRC).

This instrument, still under development, is specifically designed for community colleges. A preliminary form has been administered at 40 community colleges this spring; the final form is expected this fall. We shall select items from SRC that are especially appropriate to our investigation.

6. Non-standardized sources.

A number of ETS researchers are developing or have developed student attitude questionnaires. We expect to use directly or to adapt pertinent items for this project. The staff also will design a small number of items that are not available elsewhere and that deal with issues related specifically to CAI. Of course, all items in this category will be pretested before use at the participating colleges.

To prevent over-testing students, we shall not ask anyone to complete all of the above questionnaires. We anticipate, instead, that three or four samples of 50-100 students each from courses dealing with appropriate subjects will be used at each participating college each semester. Thus, no student will be asked to spend more than half an hour completing questionnaires.

The second significant group whose attitudes and activities should be assessed is faculty and counselors at the participating colleges. The instructor's role will differ in the two demonstrations and, therefore, will necessitate different data collection procedures in subsequent years; however, the necessary baseline data will be the same for both projects. Interest will center on changes in the activities of instructors and their attitudes toward certain issues related to the implementation of CAI. The assessment of instructor attitudes should include general reactions to computers and CAI, student-faculty relationships and the general college atmosphere,

information on resources used for course materials and test questions, and opinions on responsibility for course content, responsibility for grades, individualization of instruction, importance of traditionally defined subject matter, uses of tests, and importance of defining course objectives.

There will be several sources of data on instructor attitudes and activities. First, we have prepared a draft attitude questionnaire (See Appendix A) dealing with the topics mentioned above; this will be given to all faculty and counselors at participating institutions as soon as it has been pretested, revised, and approved. Second, small group discussions with 10-12 concerned teachers and counselors will be held at each participating college near the end of each semester. Informal and open-ended, the discussion will center on the questionnaire, the issues raised in it, and general developments in the project. If these discussions bring to light issues needing additional clarification or documentation, subsequent questionnaires may be developed and administered. Third, a small number of selected faculty members will be asked to keep a daily log of activities for a one week period. Such an instrument has been developed by Professor Bruce Biddle at the University of Missouri and has been used in a number of studies on teacher roles. Thus, a large amount of comparative data, as well as a thoroughly developed scoring system, is available. Other such instruments have also been developed. We have not yet made the final decision about which is the best one. The number of instructors asked to keep these logs will depend on the number available at participating colleges and the cooperation that can be obtained. Half of these instructors will log a week in the early part of the term, and half will be asked to log the final week of the term. This process will not be repeated each term. Finally, faculty members who are preparing materials for the Illinois project will be interviewed individually at periodic intervals throughout the year. They will be asked about their activities, the status of their relationship with the developers, their expectations, problems, and progress.

We fully recognize how sensitive the issues are that we intend to explore with faculty members. Due caution will therefore be used in soliciting cooperation from each college administration, faculty senate, teachers' union, and any other relevant organization. All responses will, of course, be held in strictest confidence, and no references to individuals will be made in any reports, nor information be released to anyone outside the directly involved ETS staff.

A final group of persons asked to furnish information about attitudes and activities will be members of each college's administration, probably the registrar and dean of instruction. They will be interviewed each semester for their opinions on the relevant issues mentioned above. They will also be asked to furnish appropriate statistical data on dropout rates, popularity of follow-on courses, and other such topics.

Experimental Design and Data Collection Plans

1. MITRE - Community Colleges

Since the starting date for the MITRE demonstration is expected to be postponed until September 1974 we plan to delay the starting date for the baseline data collection. Rather than starting baseline data collection in the fall 1972 term (semester or quarter) we plan to start with the spring 1973 term. This will make it possible to collect 3 semesters (or 4 quarters) of baseline data before the start of the demonstration.

Baseline data collection could be delayed until the fall of 1973 and still cover a full academic year. However, current MITRE plans still have a target hardware installation date during the spring of the 1973-74 academic year, and this installation might be expected to influence the baseline data collected in the spring of 1974. Thus, we thought it would be better to start during the preceding spring.

Achievement tests and attitude questionnaires will be administered to a sample of the target population of students at the end of each term. The target population will consist of all students enrolled in English or math courses for which equivalent credit could be obtained from the CAI courses during the demonstration period. For each of the four courses (two in math and two in English) achievement test items and questionnaires will be administered to a sample of approximately 100 students each term. Pretest data at the beginning of the course will not be collected; however, previous test scores available through college records (if any) will be obtained. The test data obtained from college files, such as CGP or ACT scores, will be used for purposes of matching and as covariates in the data analyses.

The "Survey of Instructor Activities and Attitudes" (See Appendix A) will be administered to all faculty in the spring of 1973 and will be followed up by small group discussions with selected faculty members before the end of the school year. Further group discussions will be held twice at each college during 1973-74 and additional questionnaires will be used if needed. Administrators will be interviewed individually at the times of the group discussions.

The analysis and reporting of baseline data obtained during the 1972-73 and 1973-74 academic years will be limited to simple descriptive statistics including means, standard deviations, and reliability estimates for each of the achievement and attitude scales. After the collection of comparable data from students participating in the demonstration, however, these data will be used for some of the primary types of comparisons. Specific data analysis considerations are discussed in a later section.

2. University of Illinois - Community Colleges

The basic approach to data collection and analysis for the community colleges participating in the University of Illinois demonstration will be the same as the one described above for the MITRE demonstration. However, the timing will be different for the two projects, owing to their different schedules. The baseline data collection for the community colleges in the University of Illinois demonstration will begin with the fall 1972 term. Achievement and attitude data will be collected at the end of each term during the 1972-73 academic year. The analyses of these data will follow the same pattern as that described above for the MITRE project.

Data will be obtained for samples of approximately 50 students per term in each of the five target courses (Biology, Chemistry, Accountancy, Mathematics, and General Education Diploma) at each participating college. The students will be selected from courses that are expected to be partly taught by PLATO during the demonstration years.

The faculty questionnaire will be administered as soon as pretesting and revisions are completed, it is hoped by mid-November. Subsequent group discussions are planned for mid-December and April -- with a second questionnaire, if needed, in mid-May. CAI authors and responsible administrators will be interviewed individually in the fall of 1972 and the spring of 1973

Since the University of Illinois plans to have terminals installed at participating community colleges during the 1972-73 academic year, the baseline results could be confounded in the sense that some students will have some experience with PLATO during the baseline year. Questionnaire data will also be obtained at each institution, however, to ascertain whether students have had any experience with the PLATO system. Students with PLATO experience will be eliminated from the baseline groups. If there is a sizeable number of students who have had experience with PLATO, comparisons will be made between these students and baseline students without exposure to PLATO to see whether the group without exposure is sufficiently representative to be useful as a comparison group for the main demonstration.

3. University of Illinois - Elementary Schools

The baseline data collection for the elementary school demonstration will follow a different pattern from the community college demonstrations. A pretest-posttest design will be used with the elementary schools. Achievement tests in reading and arithmetic and an attitude-toward-reading questionnaire will be administered in fall, 1972. (Samples of reading questionnaires being considered for use are included in Appendix B.) The same attitude questionnaire and parallel forms of the achievement tests will be administered in May 1973. These data will be obtained for all students in grades 1, 2, and 3 in the four demonstration schools. As with the community colleges,

students in the elementary schools are expected to have some exposure to PLATO during the baseline year. Students with and without PLATO experience will be treated separately in the analyses.

General Considerations in Estimating the Effectivenss of CAI -- Control Groups

The analyses of data obtained from quasi-experimental evaluations and the interpretations of these analyses have recently been the subject of considerable controversy. A paper by Campbell and Erlebacher (1970a) and the exchange of papers which it engendered (Campbell & Erlebacher, 1970b; Cicirelli, 1970; Evans & Schiller, 1970) exemplify some of the basic issues in this controversy. From the technical standpoint, the crux of the difficulty in designing evaluations of educational programs is that the evaluator lacks the power of randomization. Without random assignment it cannot be assumed that groups receiving different treatments were comparable prior to the introduction of the treatments. The evaluator is thus faced with the problems of demonstrating the comparability of the groups prior to treatment or, as is more often the case, attempting to take preexisting group differences into account in the analyses. A general discussion of these issues is given in Rubin (1972).

Hence it is important to try to find non-CAI groups of students who are similar to the CAI groups of students. There appear to be three collections of non-CAI students who are potentially similar to the CAI students:

(1) students from previous year, before introduction of CAI -- "baseline students"

(2) students from similar non-CAI classes in the same year

(3) students from other institutions in non-CAI classes.

The baseline students will provide one important control group. The usefulness of these data will depend upon general similarity of student characteristics from one year to the next and a general commonality in purpose for courses taught during the baseline and demonstration years. Although reasonably good comparability is anticipated, it seems desirable to augment these comparisons with a different type of comparison group.

Wherever possible, comparison groups will be formed during the demonstration year. Several approaches will undoubtedly have to be used and the details of the procedures will have to be worked out after the participating schools have been surveyed and details of participation specified. In cases where there are sufficient students taking

a course so that only part of them can be accommodated on the CAI system, comparison groups will be formed from students taking comparable non-CAI courses. If administratively feasible, the CAI and non-CAI groups would be formed by random assignment of students. When complete random assignment is not possible, it still may be possible to have partial random assignment. For example, if more students sign up for a given CAI course than can be accommodated, some students obviously would have to be assigned to non-CAI courses. Rather than our using the typical first-come-first-served approach there would be considerable advantage to using a random procedure to determine which students will be in the CAI group.

In addition, it may be possible in some instances to identify reasonable groups outside the institution. For example, if MITRE uses one of the Northern Virginia Community College District campuses as a demonstration site, another district campus might serve as a reasonable comparison group.

The comparability of the student characteristics is one of the concerns in the formation of control groups. Comparability of course content is a second concern. Participating institutions will make some judgments of course comparability when the determinations of course credits are made. Greater comparability could be achieved, however, if common instructional materials were used in the CAI and non-CAI courses. If possible, we plan to provide cooperating instructors of non-CAI courses with the CAI instructional materials. These instructors would then be asked to use the CAI materials as extensively as possible in their non-CAI courses.

Assume we obtain a "matched" sample of students from each of the three control groups and they are exposed to "equivalent" courses. If the comparison of CAI to non-CAI were similar for each of these three control groups, we could be quite confident in our estimate of the effect of CAI, since the biases in the three control groups should be very different. Of course the problem of obtaining a good estimate of the effect of CAI for any comparison is non-trivial.

The most appropriate mode of analysis depends upon which model and associated assumptions are thought to be most reasonable. For example, if all the variables that affect posttest scores are used as matching variables, and exact matches have been obtained, then the usual average difference in matched pairs is the proper estimate of the effect of the treatment. If the matching is not perfect but we believe the relationship between posttest and relevant variables is basically linear, the analysis of covariance is appropriate. If we feel that the matching variables are the relevant variables but are imperfectly measured, then under usual normality assumptions we can further adjust scores for errors of measurement. On the other hand,

we may feel that there are many other important variables besides the matching variables. If we knew, in the absence of a treatment, that the difference in posttest scores would equal the difference in pretest scores, it follows that the gain over time in difference scores is the appropriate estimate of the treatment effect. If we knew, in the absence of a treatment effect, that the treatment group would remain the same number of standard deviations below the control group on the posttest as on the pretest, the gain over time in standard score differences (i.e., difference in treatment-effect correlations) is appropriate. We shall use all of these methods (as well as others, perhaps) to estimate the effect of computer-based education. With each estimate we shall clearly specify the associated assumptions and comment on their plausibility. Conclusions will be based on a comparison of the estimates' variability and relative plausibility.

Obtaining Matched Pairs of Students with and without CAI

There are two major classes of problems that arise when using matched samples in research. The first is the trade-off between close individual matches and reduced sample size. This trade-off is often addressed as the problem of "attrition" and "incomplete matching." Note that this problem may exist in experimental as well as observational work -- increasing precision in experiments by demanding very tight blocking may reduce the number of units available to be studied.

The second class of problems that arises when using matched samples is generally discussed only in observational work. Even if we assume exact matches on all matching variables used, are treatment and control groups really comparable in the sense of estimating treatment effects? Two phrases often used to describe the associated problems are "selection" and "regression to the mean." These topics have been the subject of much literature recently and continue to be a source of controversy. For recent literature on these topics, see Campbell and Erlebacher (1970a) and Althauser and Rubin (1970). The extent to which the obtained treatment and control groups will be comparable (either by matching or other adjustment) will be the subject of substantial investigation and discussion when we analyze the data. The discussion will of necessity revolve around which of several competing models is most appropriate for the data in hand. The problems of selection and regression to the mean exist only if the model being used to analyze the data is incorrect. As indicated earlier, we will use different models to analyze the data and compare resulting estimates with respect to the reasonableness of the underlying assumptions. Also, by matching participants from several control groups we shall have estimates with different sampling biases.

For the present, let us restrict ourselves to the first class of problems, that of obtaining good matched samples of reasonable size. The recent paper by Althauser and Rubin (1970) fairly carefully describes the relevant issues, and for further details the reader should refer to that article.

Ideally, for each CAI student we should have a non-CAI student identical in all relevant aspects. Clearly this is impossible. First, we must restrict our attention to a subset of possibly relevant matching variables. It is our judgment that these variables are college-file data.

Next, we must consider sample-size constraints. Clearly, in order to choose a matched subset of students we must have a larger sample of non-CAI students than CAI students. Some indications of sample size may be found in Rubin (1973a,b).

The last problem with respect to choosing samples is defining a "close" or "best" match. The Althauser and Rubin paper (1970) is one of a few giving a complete specification of a multivariate matching method. Even though there are no statistical properties derived or displayed, the method is distinctly a possible one to use. Another generally applicable class of methods is presented in Rubin (1970). Those methods are the multivariate generalizations of univariate matching methods investigated in substantial detail (Rubin, 1973a,b) and are not only very easy to use in practice but also have some very pleasing statistical properties. Current research on these methods should enable a more knowledgeable decision to be made shortly on choice of matching method. In any case, a reasonable procedure may be to produce several matchings by alternative methods and choose the one that satisfied the most criteria. One would hope, by this attack, that the resultant matched samples would be as well matched as possible, given the constraints on sample size.

Analyses to Assess CAI Program Effectiveness

Standard covariate analyses. The basic procedures will use standard covariance analysis with the pretests, when available, and various student and school characteristics as the inputs and post-test as the output. The basic comparisons will be between the CAI students and the matched sets of non-CAI students.

It should be emphasized, however, that due to the quasi-experimental nature of the study, such analyses may be more properly regarded hypothesis exploration than as hypothesis testing. In particular, conclusions regarding the relative effects of CAI and non-CAI may be weakened by the constraints of the quasi-experimental design.

Covariance analysis adjusted for errors of measurement. The second major approach to the analyses of program effects will be to use adjusted scores in a manner similar to the analysis of covariance. Although analysis of covariance has been commonly suggested in a number of educational and psychological statistics texts as an appropriate means of adjusting for pre-existing group difference, the technique has recently been severely criticized. A number of authors have underscored the limitations of this method for the purpose of adjusting for pre-existing group differences (e.g., Campbell and Erlebacher, 1970; Evans and Anastasio, 1968; Lord, 1967, 1969). Part of the difficulty is due to the violation of the assumption of the equality of within- and between-group regressions. Another difficulty is the bias due to unreliability of the covariate (Lord, 1960; Porter, 1967; Werts and Linn, 1971).

The data analyses will follow the same lines as the analyses described in the preceding section except that errors of measurement will be taken into account.

Analysis of difference scores. The simple difference between pretest and posttest is an intuitively natural approach to comparing the elementary school CAI students with non-CAI students. The reasoning behind this approach is simply that in the absence of any treatment effect one would expect the students in the two groups to grow at the same rate on the average. Although this simple approach is intuitively appealing it has frequently been faulted (see, for example, Lord, 1963; and Cronbach and Furby, 1970). The regression effect is of particular concern in cases where subjects are not assigned to groups at random and there are preexisting differences between the groups.

Despite the difficulties with the difference score approach, it does provide an alternative form of analysis based on a reasonable alternative model. Thus, the analysis of difference score will provide results which can be compared to those of other analyses and enable a comparison of the effects that different assumptions have on the results.

Treatment-effect correlations. The fourth major approach to the analysis of the effects of programs on the elementary school student performance is one recently suggested by Campbell (1970) and referred to as treatment-effect correlations. In this approach correlations of the posttests with the treatment are compared to correlations of the pretest with the treatment. The treatment variable is coded 0 or 1.

In situations where the group with lower scores on the posttest receives the treatment coded 1 and the initially higher scoring group receives the treatment coded 0, a negative point-biserial correlation between treatment and pretest will be obtained. If the treatment is effective in reducing the between-group variance relative to the within-group variance then the correlation between treatment and posttest would be expected to be closer to zero than the treatment-pretest correlation.

This analysis is equivalent to an analysis of the difference between standardized pretest and standardized posttest scores. In situations where no treatment effect is expected, initially low-scoring groups tend to fall further and further below the norm with the passage of time. From this observation, one would expect that, in the absence of a treatment effect, the differences between group means of the posttest would be larger than differences between group means on the pretest. The use of standardized scores or "treatment-effect correlations" is an attempt to adjust for the spread of group means in the absence of a treatment effect.

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TECHNICAL ANALYSIS

At this point in the project neither the MITRE nor the Illinois system is close enough to full operation to permit any meaningful measures of technical performance. Consequently, our interim role will be to monitor system development, to comment on decisions that will importantly determine the nature of the final systems, and to see to it that an adequate method of collecting system performance data is incorporated into the two projects well before field trials begin. In order to monitor developments, a number of ETS staff and two outside consultants visited both Illinois and MITRE in the past several months for detailed briefings on the projected hardware and system design. Our thoughts on the progress to date of the two systems can be summarized as follows:

The TICCIT System

It appears to us that MITRE has made very substantial progress over the past three months in the design of the final system. Software designs appear to have firmed up considerably, although it still remains to be seen whether enough code can be kept core-resident and/or whether disc accesses can be optimized enough to support as many as 100 terminals. The change to an MOS shift register storage for the video refresh memory seems to us a great improvement over the previous scheme, although we have some reservations about the new method as well. Our principal concern here is that the dynamic shift register memory is especially prone to data loss from momentary power losses. Because TICCIT is expected to run in the average school, the system power supplies will have to be designed to handle the substantial voltage fluctuations and occasional momentary power outages encountered in some communities; this could prove expensive. One would not expect to provide a full stand-by power source for each TICCIT installation, but at the very least the system ought to be capable of recovering automatically and gracefully from momentary power failures, without operator intervention and with little or no disruption of student displays.

The addition of color to the video display increases a concern we have already expressed -- namely, that students not receive an excessive amount of radiation from prolonged exposure to the video screen at relatively short viewing distances. Color displays typically require higher accelerating voltages and generate correspondingly more radiation at the tube face. We expect to make radiation measurements ourselves shortly, and would encourage MITRE as well to monitor this aspect of the project.

The PLATO System

PLATO IV appears to be developing more or less on schedule. There have been no major technical changes in the past few months that require comment from us. Our impression is that the new terminal is operating pretty much as expected, and although the packaging could stand to be improved, the basic terminal appears to be reliable. Some development work remains for the audio device, but we foresee no substantial difficulties there.

Two questions that have come up in recent visits deserve some comment. One has to do with the arbitrary limit of 25 ms. of processing time for a user time slice. In an evening of exploring programs under development for PLATO IV, we found this time unit apparently exceeded a number of times by portions of several different programs. It would appear that at the very least authors need more instruction in how to avoid this problem. The second question has to do with the capacity of the extended core storage. It is clear that PLATO cannot in its present form support 4000 terminals engaged in 4000 different programs. The system design is clearly built around the assumption that a substantial number of users are sharing the same programs (i.e., an entire class is sharing one or at most a few units in ECS). It will be important to obtain fairly soon an estimate of just how many different units of "average" size (whatever that means) can be simultaneously resident in ECS.

Data Collection

We assume that both TICCIT and PLATO will run more or less on schedule. Our task, then, will be to assess how well they run. Some of the measurements we expect to make are straightforward, and many of these can be drawn from the project's own records. These include:

- Distribution of time to total system failure
- Analysis of causes of total system failure
- Distribution of system repair times
- Analysis of system repair costs, including labor and parts
- Estimates of cost of required spare parts and stand-by service personnel to keep system operating satisfactorily
- Distribution of time to terminal failure (including failures due to communications lines)

- Analysis of causes of terminal failure

- Distribution of terminal repair times (including service personnel travel time, if applicable)

- Analysis of terminal repair costs, including labor, travel, and parts

- Estimates of cost of spare parts and/or backup terminals required on site to maintain satisfactory system operation

In addition to these measures of system reliability, we expect to measure a number of system performance variables, including:

- Distribution of terminal response times under differing system loads

- Ability of system to withstand and/or recover gracefully from power fluctuations or failures, and from communications problems

- Ability of single terminal to recover gracefully from program, terminal hardware, or communications problems

- Analysis of the loads and conditions most likely to seriously degrade each system

- Analysis of the relative ease with which system software and courseware can be updated

- Estimates of the magnitude of consulting manpower required to help users obtain satisfactory use of the system

One special set of measures will have to do with aspects of the terminal itself, and will include:

- Analysis of terminal comfort (freedom from eyestrain, legibility of text and pictures, sound levels, keyboard and function "feel")

- Analysis of terminal safety (radiation hazards, electrical hazards, mechanical dangers)

- Analysis of terminal durability

- Special problems with terminals in schools (special electrical or environmental requirements, terminal size, special wiring requirements)

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The project reporter has compiled a bibliography of recent writings, both professional and journalistic, related to the subject of computer-based education in general and to the specific technical concerns of our research, development, and evaluation. Since the work in progress is complex and has broad ramifications, writings have been selected that are subsumed under several headings: (These rubrics are, of course, subject to change as the project develops.)

1. the use and impact of technology in society and in education

2. descriptions of new and on-going programs of computer-based education

3. educational issues related to the adoption of computers in education

4. problems in the development and implementation of computer-based education systems

5. related educational research

6. discussions relevant to the theory and practice of evaluation

7. discussions relevant to the development of instructional materials for computer-based education.

* * * *

1. Use and Impact of Technology in Society and Education

This section lists publications dealing with technology as it affects social change, social planning, and the economics of education. It annotates writings about new applications of technology, as in information and management systems. It also subsumes discussions of specific educational applications of technology, seen in the context of both the present and the future.

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APPENDICES

A. Survey of Instructor Activities and Attitudes

B. Attitudes Toward Reading Questionnaires

   a. Grade 2
   b. Grades 4 and 6

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SURVEY OF INSTRUCTOR ACTIVITIES AND ATTITUDES

As you know, your school is one of several community colleges that has agreed to participate in one of two large scale demonstrations of computer-assisted instruction (CAI), funded by the National Science Foundation. These demonstrations will attempt to show that CAI is technically sound, economically feasible, and educationally effective. The Educational Testing Service of Princeton, New Jersey will monitor these demonstrations and evaluate their technical, economic, and educational effectiveness. We are conducting this evaluation under a separate contract with the National Science Foundation so that we are not dependent upon the organizations that are operating these CAI systems but are responsible only to NSF and the public to insure that a thorough and objective evaluation is conducted.

While the educational evaluation will focus mainly upon student achievement and attitudes, we are also interested in the impact of CAI on your daily activities and your attitudes toward the various aspects of this project. Therefore, near the end of each term, we will be asking a few faculty members from your college to get together in a small group in order to discuss issues and opinions which have arisen in regard to CAI. These discussions will be held without the presence of any administrators or those responsible for the project, and we will not identify, in any way, the individuals making comments or giving us opinions. Regardless of whether you are authoring materials, planning

to use materials, unfamiliar with the project, or opposed to the project, we hope that you will be willing to share your opinions with us. If you are willing to participate in a 1-2 hour discussion on this topic, please indicate this on the first page of the questionnaire. Your affirmative response is merely an expression of interest and not a firm commitment.

We are also asking you and your colleagues, including all faculty members, counselors, and other professional staff members, to respond to a series of questionnaires. We apologize in advance for any inconvenience this may cause you and wish to assure you that the number of questionnaires will be kept to an absolute minimum, certainly no more than two per year, and that their length will never be greater than this first one. We hope that you will agree with us that the potential implications of these CAI demonstrations and the need for thorough evaluation justify the time needed to complete this questionnaire.

This first questionnaire has been designed to survey your initial impressions and existing opinions on a variety of topics related to CAI before you get very deeply involved in the project. Your complete candor in answering these questions will be greatly appreciated. Needless to say, we will hold your individual responses in strictest confidence. However, you may also be assured that the summary results will be shared with the CAI project directors so that they may take the group's opinions into account while implementing these demonstrations.

The first section consists of questions about your background, present status, and teaching practices. The second section asks for

your opinions regarding computers and CAI as you now understand it. The final section focuses on your opinions regarding various educational practices which may be influenced by these projects. After completing the questions and adding any comments about the project or the questionnaire, please return the questionnaire in the attached pre-addressed, business reply envelope.

NAME _____

COLLEGE _____

DIVISION _____

DEPARTMENT _____

POSITION _____

Please circle the appropriate letter.

1. Are you willing to participate with other faculty members and a representative of ETS in a confidential discussion of this project?

   a. Yes
   b. No

2. Are you the chairman of your department or division?

   a. Department chairman
   b. Division chairman
   c. Both of the above
   d. None of the above

3. Do you have another other administrative duties, whether or not you a department or division chairman?

   a. Full-time (specify) _____
   b. Part-time (specify) _____
   c. None

4. Is your position (other than chairmanship or temporary administrative assignment) an adjunct, acting, or temporary (less than 9 months) position?

   a. Adjunct
   b. Acting
   c. Temporary
   d. All three of the above
   e. Adjunct and acting
   f. Adjunct and temporary
   g. Acting and temporary
   h. None of the above

5. Please indicate the number of years of working experience prior to September 1972 you have in each of the following categories.

	Number of Years				
	Less Than 1	1-2	3-5	6-10	More Than 10
Elementary school teaching	A	B	C	D	E
Secondary school teaching	A	B	C	D	E
Community college teaching	A	B	C	D	E
College/university teaching	A	B	C	D	E
Educational research or administration	A	B	C	D	E
Non-teaching experience which is directly related to your courses	A	B	C	D	E
Non-related working experience	A	B	C	D	E

6. Please indicate the courses and the number of sections of each that you are teaching this term.

		Number of Sections
#1	_____	_____
#2	_____	_____
#3	_____	_____
#4	_____	_____
#5	_____	_____

Questions 7 to 23 concern the courses you listed in question 6. Column #1 refers to the 1st course you listed, #2 to the second, and so forth. Please circle one alternative per column using the same number of columns as courses listed in question 6. In other words, circle one letter in the first column to indicate your response in relationship to course #1, one letter in the second column for course #2, and so forth.

7. Who selected the textbook(s) to be used in each class?

(Courses as listed in Question 6)

	#1	#2	#3	#4	#5
Division chairman	A	A	A	A	A
Department chairman	B	B	B	B	B
Academic dean	C	C	C	C	C
Department committee	D	D	D	D	D
Personal decision of instructor	E	E	E	E	E
Other (specify) _____	F	F	F	F	F

8. What factor most heavily influences the content of each course?

(Courses as listed in Question 6)

	#1	#2	#3	#4	#5
Personal decision of instructor	A	A	A	A	A
Committee of department members	B	B	B	B	B
Dean or department chairman	C	C	C	C	C
Recommendations of professional organizations	D	D	D	D	D
State department of education	E	E	E	E	E
Professional experts from an outside organization	F	F	F	F	F
Students	G	G	G	G	G
Other (specify) _____	H	H	H	H	H

9. Which is the second most important factor in determining course content?

(Courses as listed in Question 6)

	#1	#2	#3	#4	#5
There is only one factor.	A	A	A	A	A
Personal decision of instructor	B	B	B	B	B
Committee of department members	C	C	C	C	C
Dean or department chairman	D	D	D	D	D
Recommendations of professional organizations	E	E	E	E	E
State department of education	F	F	F	F	F
Professional experts from an outside organization	G	G	G	G	G
Students	H	H	H	H	H
Other (specify) _____	I	I	I	I	I

10. Which of the following is most important for students to learn in each course?

(Courses as listed in Question 6)

	#1	#2	#3	#4	#5
Specific skills	A	A	A	A	A
Theories, concepts, general understanding	B	B	B	B	B
Specific facts or a body of knowledge	C	C	C	C	C
Values, appreciations, attitudes toward subject	D	D	D	D	D
Sense of personal progress, self-confidence or esteem	E	E	E	E	E
Other (specify) _____	F	F	F	F	F

11. Which is the second most important for students to learn?

(Courses as listed in Question 6)

	#1	#2	#3	#4	#5
Specific skills	A	A	A	A	A
Theories, concepts, general understanding	B	B	B	B	B
Specific facts or a body of knowledge	C	C	C	C	C
Values, appreciations, attitudes toward subject	D	D	D	D	D
Sense of personal progress, self-confidence or esteem	E	E	E	E	E
Other (specify) _____	F	F	F	F	F

12. If the objectives of the course are stated to students, how are these objectives stated with the most emphasis?

(Courses as listed in Question 6)

	#1	#2	#3	#4	#5
In terms of the content to be covered	A	A	A	A	A
In terms of the requirements to pass or attain particular grades	B	B	B	B	B
In terms of desired behaviors or abilities at the end of the course	C	C	C	C	C
Not stated specifically	D	D	D	D	D
Other (specify) _____	E	E	E	E	E

13. If the objectives of the course are stated to students, what is the first way this is done?

(Courses as listed in Question 6)

	#1	#2	#3	#4	#5
In a publication available to all students prior to registration	A	A	A	A	A
In a hand-out at the beginning of the course	B	B	B	B	B
Verbally during the first few class periods	C	C	C	C	C
During the course as an integral part of instruction	D	D	D	D	D
Not stated specifically	E	E	E	E	E
Other (specify) _____	F	F	F	F	F

14. Which of the following is the most important source of test questions for you?

(Courses listed in Question 6)

	#1	#2	#3	#4	#5
Textbook publisher	A	A	A	A	A
Department committee	B	B	B	B	B
Personal effort	C	C	C	C	C
Colleagues (past or present)	D	D	D	D	D
Standardized tests	E	E	E	E	E
Other (specify) _____	F	F	F	F	F
No tests are given.	G	G	G	G	G

15. Which is your second most important source of test questions?

(Courses listed in Question 6)

	#1	#2	#3	#4	#5
Textbook publisher	A	A	A	A	A
Department committee	B	B	B	B	B
Personal effort	C	C	C	C	C
Colleagues (past or present)	D	D	D	D	D
Standardized tests	E	E	E	E	E
Other (specify) _____	F	F	F	F	F
No tests are given.	G	G	G	G	G

16. What type of test questions do you use most often?

(Courses listed in Question 6)

	#1	#2	#3	#4	#5
Multiple-choice questions	A	A	A	A	A
Matching questions	B	B	B	B	B
Other objective questions	C	C	C	C	C
Essay questions	D	D	D	D	D
Short-answer questions	E	E	E	E	E
Fill-in-the-blank questions	F	F	F	F	F
Other (specify) _____	G	G	G	G	G
No tests are given.	H	H	H	H	H

17. What is the second most common type of question in your tests?

(Courses as listed in Question 6)

	#1	#2	#3	#4	#5
Only one type is used.	A	A	A	A	A
Multiple-choice questions	B	B	B	B	B
Matching questions	C	C	C	C	C
Other objective questions	D	D	D	D	D
Essay questions	E	E	E	E	E
Short-answer questions	F	F	F	F	F
Fill-in-the-blank questions	G	G	G	G	G
Other (specify) _____	H	H	H	H	H
No tests are given.	I	I	I	I	I

18. By whom are the final grades for each course primarily determined?

(Courses as listed in Question 6)

	#1	#2	#3	#4	#5
Individual instructor	A	A	A	A	A
Committee of faculty who teach various sections of course	B	B	B	B	B
Course coordinator	C	C	C	C	C
Results of standardized test	D	D	D	D	D
Individual student and instructor in consultation	E	E	E	E	E
Other (specify) _____	F	F	F	F	F

19. How much of your final course grades are determined by student's papers or projects?

(Courses as listed in Question 6)

	#1	#2	#3	#4	#5
More than half	A	A	A	A	A
Substantial amount	B	B	B	B	B
Fair amount	C	C	C	C	C
Very little	D	D	D	D	D
None	E	E	E	E	E

20. How much of your final course grades are determined by weekly or more frequent homework assignments done out of class?

(Courses as listed in Question 6)

	#1	#2	#3	#4	#5
More than half	A	A	A	A	A
Substantial amount	B	B	B	B	B
Fair amount	C	C	C	C	C
Very little	D	D	D	D	D
None	E	E	E	E	E

21. How much of your final course grades are determined by attendance, recitation, or lab work in class?

(Courses as listed in Question 6)

	#1	#2	#3	#4	#5
More than half	A	A	A	A	A
Substantial amount	B	B	B	B	B
Fair amount	C	C	C	C	C
Very little	D	D	D	D	D
None	E	E	E	E	E

22. How much of your final course grades are determined by quizzes, tests, or examinations which are completed either in class or out of class?

(Courses as listed in Question 6)

	#1	#2	#3	#4	#5
More than half	A	A	A	A	A
Substantial amount	B	B	B	B	B
Fair amount	C	C	C	C	C
Very little	D	D	D	D	D
None	E	E	E	E	E

23. How are final grades in each course distributed?

(Courses as listed in Question 6)

	#1	#2	#3	#4	#5
With set proportions for each grade ("on the curve")	A	A	A	A	A
According to an absolute standard	B	B	B	B	B
According to a relative standard which is based on overall class performance	C	C	C	C	C
Other (specify) _____	D	D	D	D	D

24. Which of the following instructional techniques or resources have you used in any of your courses? (Circle all that apply.)

a. Lectures
b. Discussion sections
c. Field expeditions
d. Laboratory experiences
e. Individual assignments (e.g, papers, class presentations, projects)
f. Group assignments
g. Textbooks
h. Books of readings
i. Workbooks
j. Outside readings
k. Cassettes
l. Tapes
m. Programmed texts
n. Computers
o. Film strips or slides
p. Motion pictures
q. Recorders
r. Television
s. Other (specify) _____

_____

25. Are there any additional instructional resources you would like to use in your courses?

a. No
b. Yes (specify) _____

_____

What prevents their use? _____

_____

26. What is the average time you spend preparing a course before the term begins?

    a. Less than one week

    b. More than one week and less than three weeks

    c. More than three weeks and less than five weeks

    d. More than five weeks

27. What is the average time you spend during the term preparing for each hour of class time? If you make the same presentation to more than one section, count it as only one hour of class time.

    a. Less than one hour

    b. More than one hour and less than two hours

    c. More than two hours and less than three hours

    d. More than three hours

28. Of the time you spend dealing with your teaching duties (in a broad sense), approximately how much is spent on each of the following activities?

	More Than Half	Substantial Amount	Fair Amount	Very Little	None
Conducting class	A	B	C	D	E
Preparing lectures, discussions, etc.	A	B	C	D	E
Preparing tests	A	B	C	D	E
Grading tests	A	B	C	D	E
Counseling students on course work	A	B	C	D	E
Counseling students on other matters	A	B	C	D	E
Advising or coaching student organizations	A	B	C	D	E
Informal discussions with students	A	B	C	D	E
Committee meetings	A	B	C	D	E
Administrative duties	A	B	C	D	E
Interaction with colleagues	A	B	C	D	E
Reading or attending lectures to enhance your own knowledge	A	B	C	D	E
Other (specify) _____	A	B	C	D	E

_____

29. In which of the following activities have you participated at any time? (Circle as many as apply.)

a. Taking a course on computer programming.

b. Working as a computer operator.

c. Working as a computer programmer.

d. Working on systems design problems.

e. Writing computer programs for research purposes.

f. Watching a demonstration of CAI.

g. Taking a course which used CAI materials.

h. Teaching a course which used CAI materials.

i. Writing CAI materials.

j. Serving on a committee to design an introductory course involving several sections and/or team teaching.

k. Taking a course on instructional design.

l. Serving on a national commission to set standards for courses in a particular area.

m. Writing a textbook.

n. Writing course objectives for dissemination to colleagues or students.

o. Writing a course outline for dissemination to colleagues or students.

p. Other related experiences (specify) _____

_____

Section II: Computers and Computer-Assisted Instruction

Please circle the letter of the most appropriate response.

30. If your charge account bill has an error, it was probably caused by

a. malfunctioning of the machine.
b. mistakes in the information given to the computer.
c. inferior design, or programming, of the computer by some person.
d. inherent shortcomings of machines.
e. factors which are unknown to me.
f. other (specify) _____

31. The best use of computer-assisted instruction (CAI) would be

a. to take over some courses completely.
b. to take over parts of some courses.
c. as an alternative for students who prefer it.
d. as an adjunct to a regular course for students who are interested.
e. for research purposes only.
f. other (specify) _____

32. The best use of CAI would be with

a. introductory or lower level courses.
b. advanced courses in the sciences, mathematics, or computer science.
c. courses which require a great deal of memorization.
d. other (specify) _____

33. What would be the best way for CAI to be used in relation to the following parts of instruction? (Circle one letter in each row.)

	Supplement	Partial Replacement	Total Replacement	No Use	Other (specify)
Lectures	A	B	C	D	E_____
Textbooks	A	B	C	D	E_____
Tutoring	A	B	C	D	E_____
Counseling	A	B	C	D	E_____
Discussion groups	A	B	C	D	E_____
Lab exercises	A	B	C	D	E_____
Other (specify)	A	B	C	D	E_____

34. Student reactions to CAI will probably be

a. negative no matter how much or how little it is used.
b. negative only if it is used to take over a course completely.
c. varied and dependent upon the student's background.
d. dependent upon the quality of the material.
e. positive if it is used as an adjunct to regular courses.
f. positive no matter how much or how little it is used.
g. other (specify) _____

35. The best criterion for judging the success of CAI would be

a. student achievement.
b. student attitudes.
c. faculty acceptance.
d. financial considerations.
e. other (specify) _____

36. The primary advantage of CAI is that it may eventually

a. relieve the instructor of routine duties and give him more time for teaching.
b. save money.
c. be a better means of instruction for some students.
d. provide remedial instruction for those who need it.
e. other (specify) _____

Please circle the appropriate letter to indicate your opinion of the following statements.

		Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
37.	Computers are a valuable tool which will benefit mankind.	A	B	C	D	E
38.	Even though computers are useful for some purposes, they will never replace man's labors completely.	A	B	C	D	E
39.	Computers are becoming more important in the everyday functioning of our society.	A	B	C	D	E
40.	Computers should become more important in the everyday functioning of our society.	A	B	C	D	E
41.	Computer-assisted instruction (CAI) has no real place in the education of college students.	A	B	C	D	E
42.	CAI is a passing fad.	A	B	C	D	E
43.	CAI is too impersonal.	A	B	C	D	E
44.	CAI cannot be used successfully with courses which demand creative activities.	A	B	C	D	E
45.	The immediate feedback and individual tailoring of courses of instruction, which are found with CAI, make it a highly desirable teaching aid.	A	B	C	D	E
46.	CAI should only be one of the many teaching methods available to students and instructors.	A	B	C	D	E

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
47. Every course will have many components which cannot be handled by CAI.	A	B	C	D	E
48. To be effective, CAI course materials should be prepared by academic departments rather than a centralized resource center.	A	B	C	D	E
49. The centralized resource center should be responsible for scheduling students on the CAI terminals.	A	B	C	D	E
50. The greatest problem with CAI will be the development of acceptable course materials.	A	B	C	D	E
51. CAI is really nothing more than a fancy teaching machine.	A	B	C	D	E
52. CAI is a potential threat to the jobs of faculty members.	A	B	C	D	E
53. Any capable instructor could develop CAI materials and use them in his courses.	A	B	C	D	E
54. CAI is one of the most significant developments in education today.	A	B	C	D	E
55. A possible use of computers in education would be the diagnostic testing and preliminary counseling of students.	A	B	C	D	E

Section III: Educational Practices

Please circle the letter of the most appropriate response.

56. The content to be covered in a course should be determined by

a. each instructor individually.
b. a committee of department members.
c. a dean or department chairman
d. the recommendations of professional organizations.
e. the state department of education.
f. professional experts from an outside organization.
g. students.
h. other (specify) _____

57. Students should have some influence on

a. the topics covered in a course.
b. the way topics are presented to the class.
c. both of the above.
d. their own assignments only.
e. none of the above.
f. other (specify) _____

58. The primary basis for the organization of a course should be

a. the intrinsic organization of the subject matter.
b. student interests.
c. the organization of the textbook.
d. the preferences of the instructor.
e. other (specify) _____

59. Individualized material beyond class presentations should be given

a. only to students who cannot handle the regular work.
b. only to exceptionally bright students.
c. to both of the above.
d. to all students.
e. other (specify) _____

60. Final grades in a course should be determined by

a. the individual instructor.

b. a committee of faculty teaching sections of that course, or the individual instructor if there is only one section.

c. the department chairman or academic dean.

d. a committee of faculty who are not directly involved in teaching the course.

e. an external examination or evaluator.

f. other (specify) _____

61. Because of the ways in which grades are presently used, they are

a. a positive incentive that keeps many students working and learning.

b. a threat that inhibits students and cause them much anxiety.

c. a detriment to education.

d. a necessary threat that preserves the discipline needed for learning to occur.

e. other (specify) _____

63. The results of tests should be used

a. to determine a student's final grade.

b. to diagnose a student's strengths and weaknesses.

c. to evaluate the instructional methods being used.

d. (a) and (b)

e. (a) and (c)

f. (b) and (c)

g. all of the above

h. other (specify) _____

Please circle the appropriate letter to indicate your opinion of the following statements.

	Stongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
64. Informal interactions between students and faculty are an important part of education.	A	B	C	D	E
65. It is more important to teach courses than to teach students.	A	B	C	D	E
66. Student feedback is very important in preparing new course materials.	A	B	C	D	E
67. The organization of curricular materials for the students at this college is best decided by this faculty.	A	B	C	D	E
68. A pre-packaged course from an outside source would not be effective with the students at this college.	A	B	C	D	E
69. Courses should be designed so that students could progress through the material in individual patterns.	A	B	C	D	E
70. College courses should be structured to allow students to proceed at their own pace.	A	B	C	D	E
71. If the necessary time and facilities were available, every student should have an education specifically designed for his needs and desires.	A	B	C	D	E
72. Course objectives should be clearly defined before textbooks, test questions, or teaching methods are chosen.	A	B	C	D	E
73. There are specific concepts or skills which every student in a class should learn.	A	B	C	D	E
74. A student's relative progress should be more important in determining his grade than is his final level of achievement.	A	B	C	D	E

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
75. Students should be judged against a well-defined criterion of accepted knowledge or skills rather than against other students.	A	B	C	D	E
76. Tests are an important and integral part of the educational process.	A	B	C	D	E
77. Most of the faculty members at this college seem to be genuinely interested in students and their problems.	A	B	C	D	E
78. It is difficult to get students at this college to work at their maximum ability.	A	B	C	D	E
79. Most of the students at this college read quite rapidly and display good comprehension.	A	B	C	D	E
80. The students at this college are more interested in "finding themselves" and developing interpersonal relationships than in acquiring knowledge or skill.	A	B	C	D	E
81. Most of the students at this college show spontaneous interest in their studies.	A	B	C	D	E
82. Students at this college often present original, stimulating ideas in class and/or informal discussions.	A	B	C	D	E
83. Most of the students at this college possess the ability to create new ideas and to think abstractly.	A	B	C	D	E

COMMENTS:

ED 072072

STUDENT NUMBER

SAMPLE

C.R.P.T.

ATTITUDES TOWARD READING

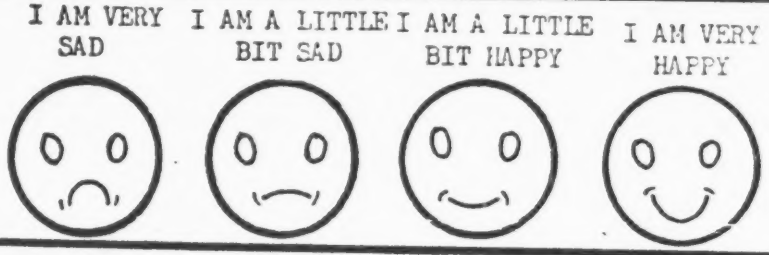
GRADE 2

STUDENT'S NAME _____

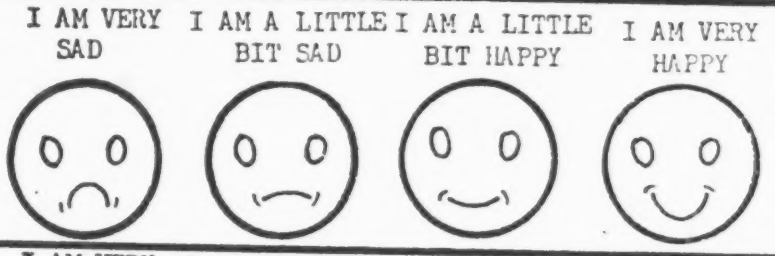
TM 000 869

• EXAMPLES •

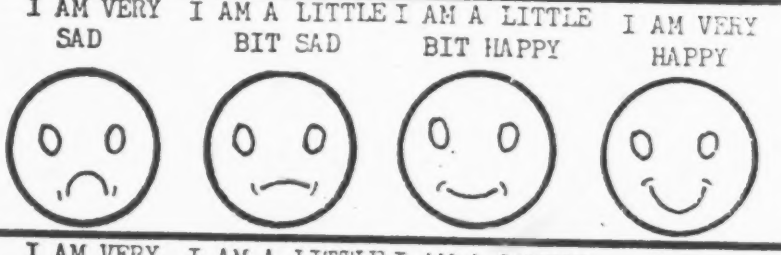
A. I am eating candy.



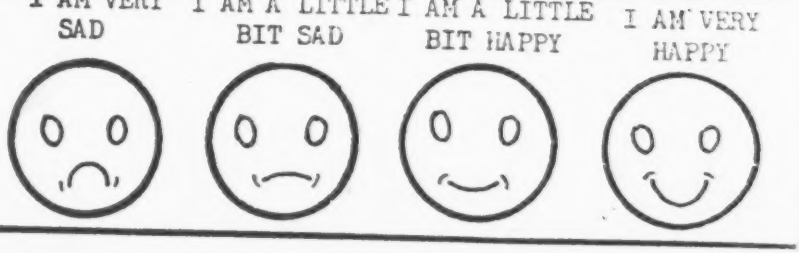
B. I have a stomach ache.



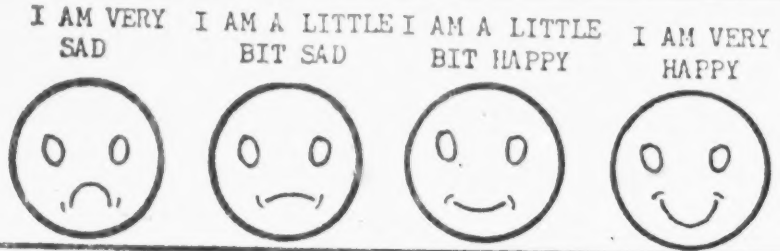
C. I lost my lunch box today.



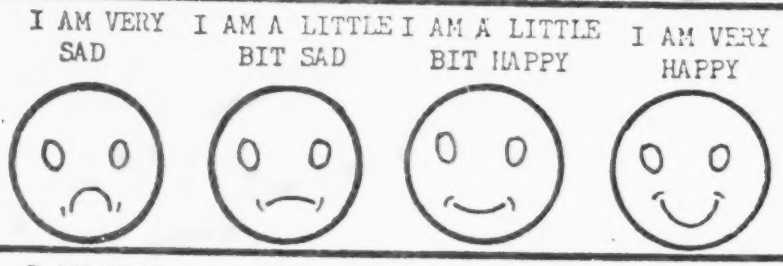
D. I am going to visit the zoo.



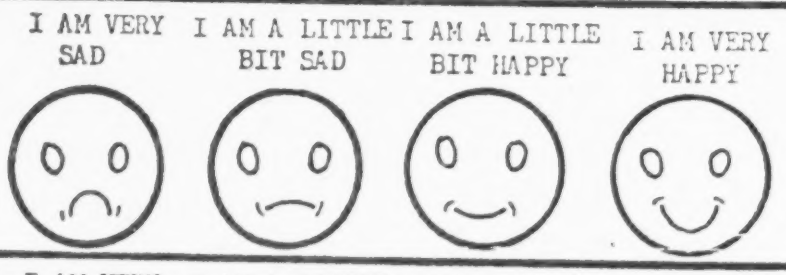
1. I am learning to read.



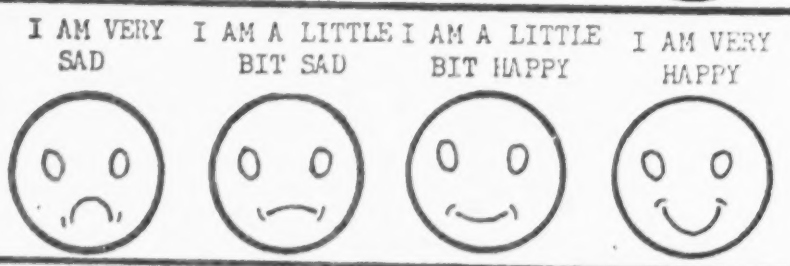
2. Today our reading class was cancelled.



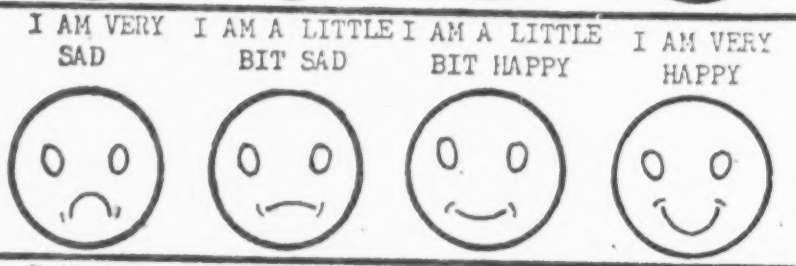
3. Someone gave me a book for my birthday.



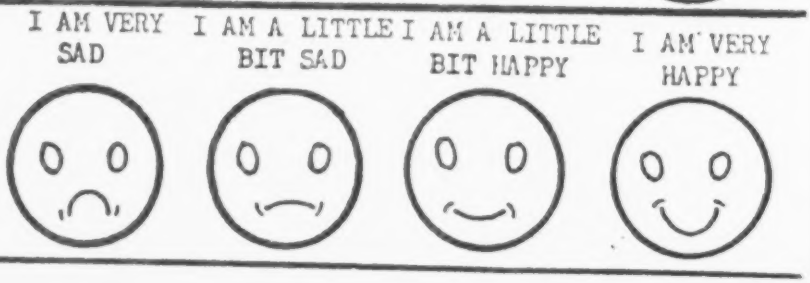
4. I am listening to the teacher read a story.



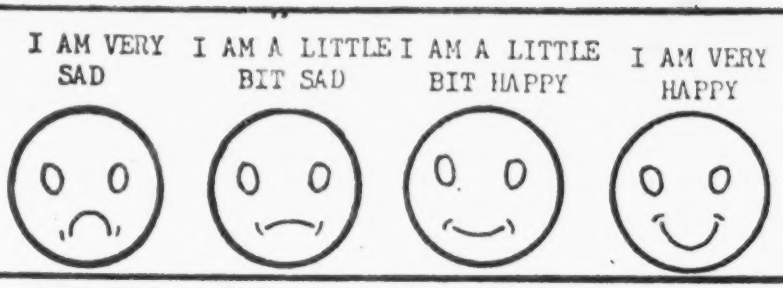
5. Someone took my library book away from me.



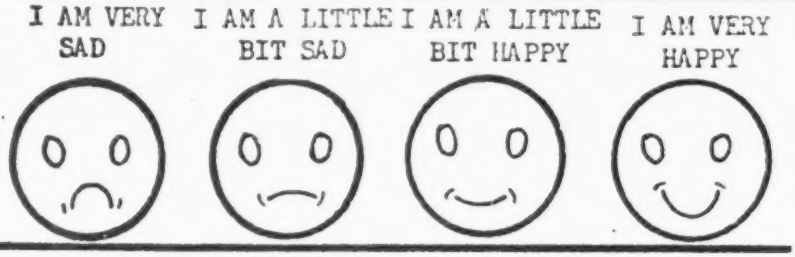
6. I am reading to the whole class.



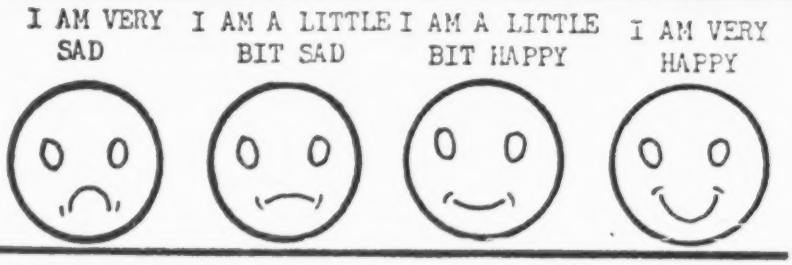
7. I took a book to bed with me last night.



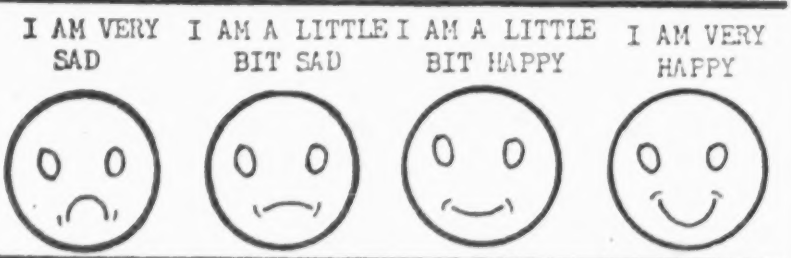
8. I am a terrible speller.



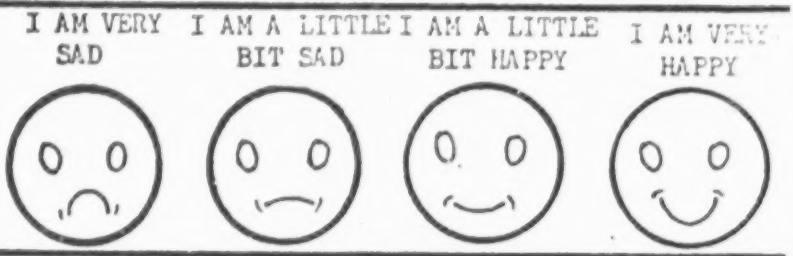
9. My mother is going to take me to the library.



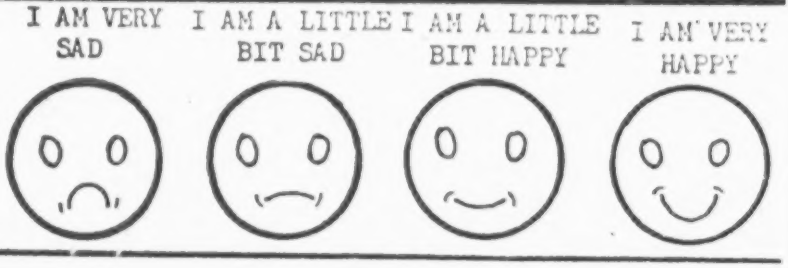
10. I just learned some new words.



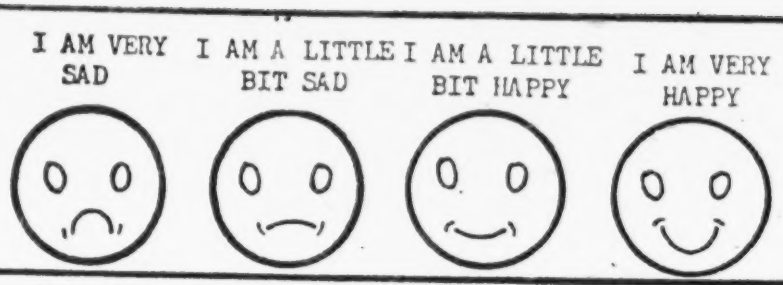
11. I lost my reading book today.



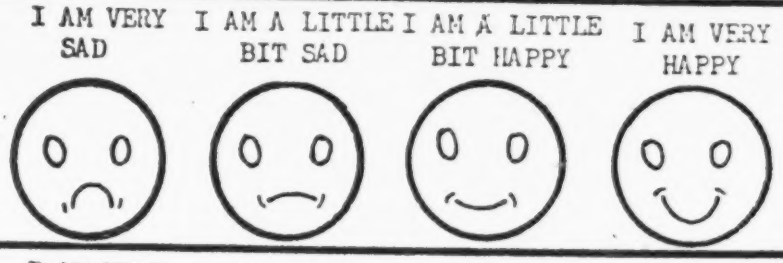
12. I am looking up a word in the dictionary.



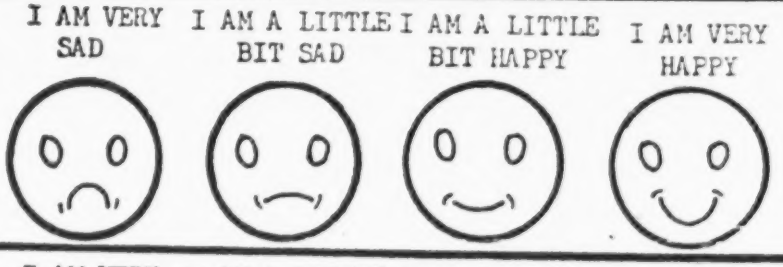
13. My sister is reading me a story.



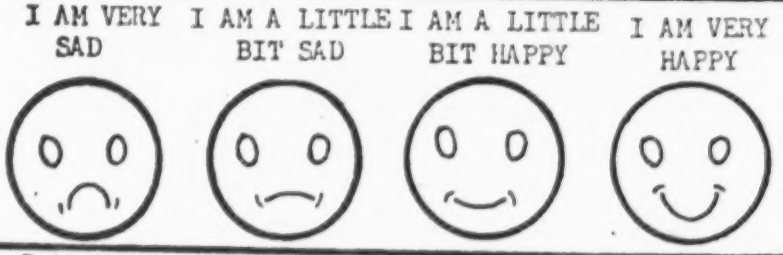
14. I am sitting under a tree reading a book.



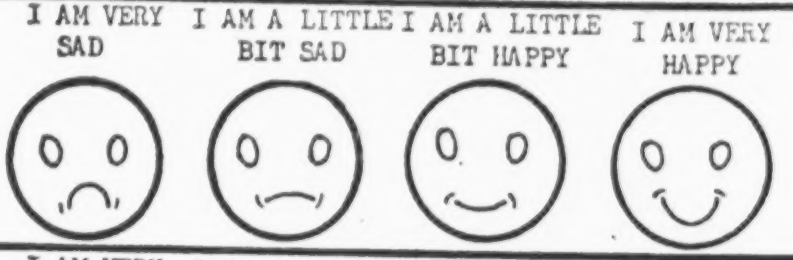
15. I didn't have enough time to finish my reading today.



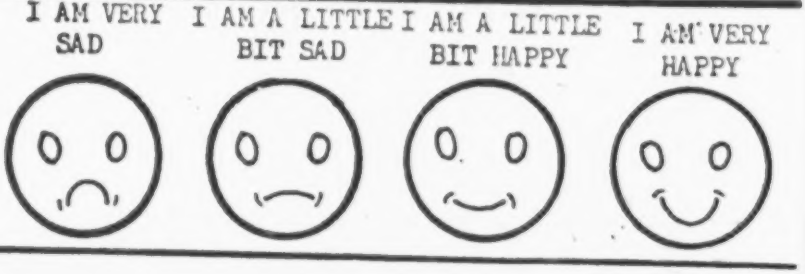
16. I am writing a poem.



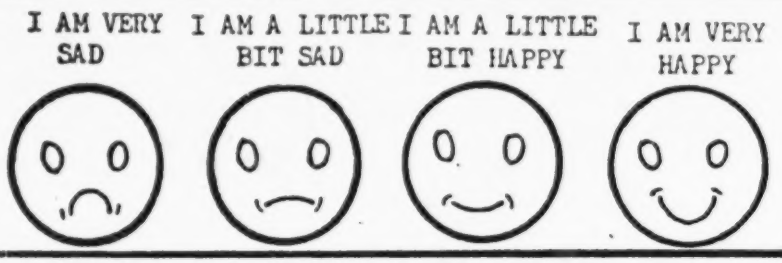
17. The newspaper is too hard for me to read by myself.



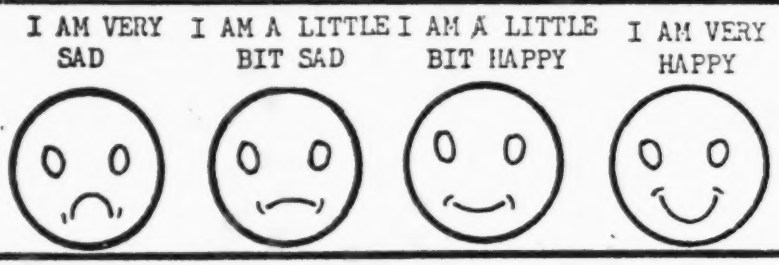
18. I have a toothache.



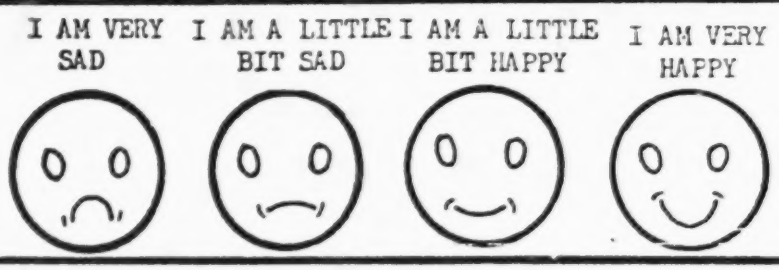
19. I am supposed to write a story in class tomorrow.



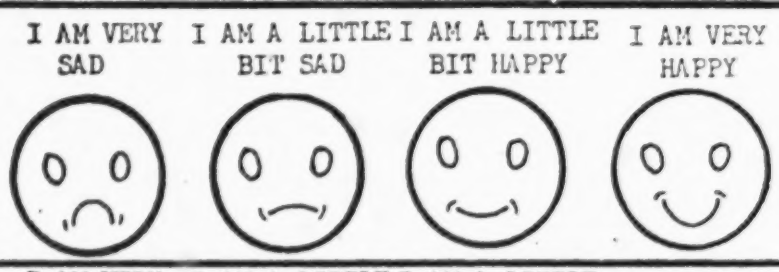
20. I am the slowest reader in my class.



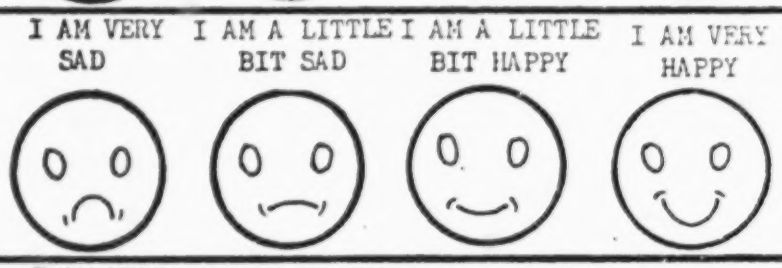
21. I can write all of the letters in the alphabet.



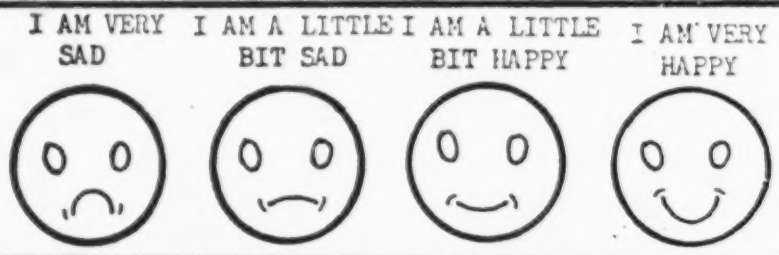
22. We were going to visit the library today, but the library was closed.



23. The teacher gave me a story to read, but it was too hard for me.



24. I can read all of the street signs.



Item No. 599148

STUDENT NUMBER

SAMPLE

C.R.P.T.

ATTITUDES TOWARD READING

GRADES 4 & 6

NAME _____

SCHOOL _____

GRADE _____

EXAMPLES

	Strongly Agree	Agree	Disagree	Strongly Disagree
A. Math is the hardest subject I know.	++	+	-	=
B. Ice cream is good at any time of the year.	++	+	-	=
C. I am a very fast runner.	++	+	-	=
D. I don't like going to the movies.	++	+	-	=

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C.R.P.T.

Attitudes Toward Reading

Grades 4 & 6

Read the following statements silently as they are read aloud to you one at a time. Then, if you agree with the statement, circle the +. If you disagree, circle the - . If you agree very much or strongly, circle the ++ . If you disagree very much or strongly, circle the = .

	Strongly Agree	Agree	Disagree	Strongly Disagree
1. Learning to read is very important.	++	+	-	=
2. Reading is the hardest thing I have to do.	++	+	-	=
3. I like to take a book to bed with me at night.	++	+	-	=
4. I get nervous when the teacher asks me to read out loud.	++	+	-	=
5. I am very proud of the way I read.	++	+	-	=
6. I learn all sorts of new things when I read.	++	+	-	=
7. I don't like visiting the library.	++	+	-	=

		Strongly Agree	Agree	Disagree	Strongly Disagree
8.	I don't think a book is a very good birthday present.	++	+	-	=
9.	I often volunteer to read aloud in school.	++	+	-	=
10.	Reading is often very boring.	++	+	-	=
11.	I am a good reader.	++	+	-	=
12.	I get worried when I am asked to read something.	++	+	-	=
13.	I like to read to people.	++	+	-	=
14.	My mother is disappointed in my reading.	++	+	-	=
15.	I dislike books.	++	+	-	=
16.	The thing I like best about school is reading.	++	+	-	=
17.	I would rather do almost anything than read.	++	+	-	=

		Strongly Agree	Agree	Disagree	Strongly Disagree
18.	I don't like to tell other people about things I have read.	++	+	-	=
19.	I spend a lot of my time at home reading.	++	+	-	=
20.	I think I am one of the best readers in my class.	++	+	-	=
21.	My classmates like to hear me read.	++	+	-	=
22.	I like to figure out new words.	++	+	-	=
23.	I don't think I want to learn another language.	++	+	-	=
24.	I am a slow reader.	++	+	-	=
25.	When I grow up I think I would like to teach children like me how to read.	++	+	-	=
26.	Reading is something I usually do without having to be told.	++	+	-	=

		Strongly Agree	Agree	Disagree	Strongly Disagree
27.	I usually understand a story the first time I read it.	++	+	-	=
28.	I feel good about my reading.	++	+	-	=
29.	Most kids my age read better than I do.	++	+	-	=
30.	I have trouble sounding out words.	++	+	-	=
31.	I have trouble reading new things.	++	+	-	=
32.	I usually take good care of books.	++	+	-	=
33.	I like talking about things more than I like reading about them.	++	+	-	=
34.	I am happiest when I am reading	++	+	-	=
35.	I like to get books for presents.	++	+	-	=

		Strongly Agree	Agree	Disagree	Strongly Disagree
36.	I never read unless someone forces me.	++	+	-	=
37.	I read whenever I have any free time.	++	+	-	=
38.	I am a fast reader.	++	+	-	=
39.	I often start to read something but give up because I don't understand it.	++	+	-	=
40.	I would like reading better ~~if~~ someone would help me with it.	++	+	-	=
41.	I like to start a new book.	++	+	-	=
42.	When a book is too hard for me, I usually stop reading it.	++	+	-	=
43.	I find reading very easy.	++	+	-	=
44.	I often read the cereal box while I am eating.	++	+	-	=
45.	I think I am one of the worst readers in my class.	++	+	-	=